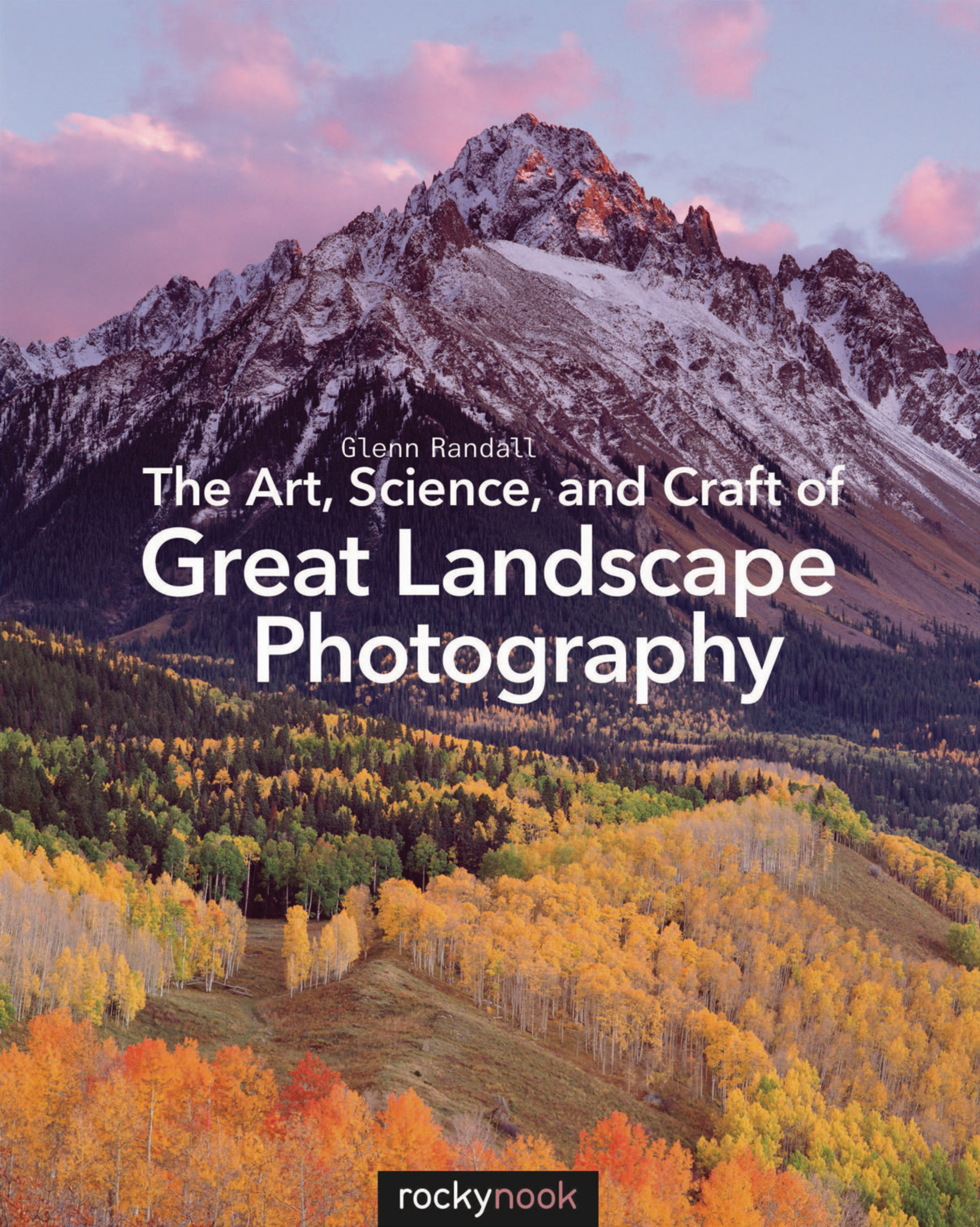

Glenn Randall

The Art, Science, and Craft of Great Landscape Photography

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The Art, Science, and Craft of Great Landscape Photography

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This book is dedicated to my parents, who first introduced me to the wilderness, to my wife Cora, who always inspires me to do my best, and to Emily and Audrey, our daughters, in hopes that their generation will continue to value, protect, and enjoy our precious wild lands.

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Acknowledgments

The roots of this book go back many years, and so there are many people to thank. My parents deserve thanks for the patience and love they showed when they took my sister and me camping, then hiking, and eventually backpacking in the wilds of California. My wife, Cora, and our children, Emily and Audrey, deserve thanks for tolerating the long absences that a career as a landscape photographer requires. I'd like to thank the many photographers whose work inspired me during my photographic journey, including Galen Rowell, David Muench, Jack Dykinga, and Tom Till. And I'd like to thank the staff at Rocky Nook for their painstaking efforts to make this book as good as it could be.

◂ Stormy sunset over Longs Peak from the Ute Trail, Rocky Mountain National Park, Colorado

Foreword

I am in love with photography books. They are the ultimate showcase for a photographer's words and images, and one of the most powerful and important legacies that we leave behind as image-makers. As a photographer, I am inspired by looking at photography books. As an educator, I learn about photography by reading books on the topic. I have surrounded myself with photography books on every conceivable subject—they are one of my few indulgences.

For six years in the 1980s, I ran a photo bookstore in Maine. Now, as director of Santa Fe Photographic Workshops, I receive photo books on a weekly basis as gifts, for review, to be considered for our campus bookstore, or from photographers who want to teach for us. Given my passion for photography books, I was delighted to receive an advance copy of Glenn Randall's new book, *The Art, Science, and Craft of Great Landscape Photography*. Glenn is one of our most popular instructors at the Workshops (and a friend), so I began pouring over his book as soon as it arrived. Immediately I realized that the book posed a pleasant dilemma for me.

Over the years of collecting photography books, I have found that they fall into three categories—books on the technical aspects of the medium, books on the creative and aesthetic side of photography, and books filled with images (monographs). All three categories are well represented in my ever-growing library. Structured person that I am, all of my books are meticulously organized by category and subject matter so I can easily find whatever I am looking for.

All was well in my world of photography books until Glenn's new book threw me for a loop. *The Art, Science, and Craft of Great Landscape Photography* is a wonderful collection of Glenn's stunning landscape images, but it is also brimming with his advice on how to craft stronger images, along with clear explanations of key photo-related topics in geography, atmospheric optics, vision, and psychology. The scientific information is always coupled with tips on how to put that information to practical use in the pursuit of great images. The book also contains Glenn's musings on the creative and aesthetic sensibilities we need as artistic beings to create compelling statements. So should Glenn's book go in the monograph category or with the technical manuals? Perhaps it should go into the creative category instead?

I was stumped. Where should I put it? On what shelf and in which category did it belong? I realized that if I didn't put this beautiful book on the

right shelf I might never find it again. A moment of panic ensued, and then I relaxed. *The Art, Science, and Craft of Great Landscape Photography* falls into all three of my categories, so it ended up on my coffee table where I can find it easily regardless of my photographic mood. Thanks, Glenn, for throwing my world of photography books completely off kilter.

I suggest you read this book because it is beautiful, informative, and inspirational. Let me know if you figure out what category to place it in.

Reid Callanan
Director, Santa Fe Photographic Workshops, January 2015

◂ Indian paintbrush and Peak Two at sunset, Grenadier Range, Weminuche Wilderness, Colorado

Introduction

I think of landscape photography as the pursuit of visual "peak experiences." I'm borrowing a term here from humanistic psychologist Abraham Maslow, who studied human potential—the heights to which humans can aspire, not the depths to which they can sink. According to Maslow, peak experiences can give "a sense of the sacred, glimpsed in and through the particular instance of the momentary, the secular, the worldly." Whoa! That sounds awfully pretentious. But when I think back on the most beautiful scenes I've ever witnessed, I understand what Maslow was talking about. Visual peak experiences are moments of extraordinary natural beauty, often ephemeral, that I seek to capture in such a way that a viewer of the photograph can share my sense of wonder and joy. Granted, my photographs rarely, if ever, achieve such lofty heights. Perhaps they never truly will. But for me it is the pursuit of visual peak experiences, and the arduous, ecstatic struggle to capture them on my camera's sensor, that makes landscape photography endlessly fascinating.

For me, these marvelous moments occur most often in wild places, particularly in the mountains. Even after 45 years, I still remember a peak experience that occurred during a camping trip with my parents in the desert mountains of southern California. I was 12 then, yearning for independence and hungry for child-size adventure. Alone, I walked away from our campsite to a saddle in a ridge overlooking a vast desert valley and the mountain ranges beyond. It was a journey that an adult would have measured in mundane yards and minutes; I measured it in emotional light-years. For a timeless interlude I meditated on the ridge, soaking in the silence and the unfathomable sweep of land. I remember feeling utterly isolated in a desolate world, and yet I recall no desire to flee back down the path to camp. Something about the sheer

▾ Candlestick Tower and Soda Springs Basin from Murphy Hogback at sunset, Island in the Sky district, Canyonlands National Park, Utah

◂ Snowmass Mountain and Capitol Peak from Buckskin Pass, Maroon Bells-Snowmass Wilderness, Colorado

unrepentant emptiness of the land compelled my awestruck attention and has demanded my return to the mountains again and again.

F. W. Bourdillon, a British mountaineer who tried to climb Everest nearly a century ago, captured my feelings when he explained the secret motivation of mountain lovers as "a feeling so deep and so pure and so personal as to be almost sacred—too intimate for ordinary mention." Mountains, he went on to say, "…move us in some way which nothing else does…and we feel that a world that can give such rapture must be a good world, a life capable of such feeling must be worth the living."

In my early teen years I hiked the valleys and scrambled up the easy peaks in California's Sierra Nevada. Then, at 15, I took up technical rock climbing. When I moved to Boulder, Colorado, to go to college in 1975, I added ice climbing to my quiver of mountain skills and began tackling difficult routes on peaks from Alaska to Argentina. In my mid-30s, after 20 years of intense mountaineering, my interest in climbing high peaks began to wane, while my interest in photographing them blossomed. Landscape photography, I found, could be just as much of an adventure as mountaineering. True, the challenges were different, but the pulse-pounding excitement and the need to perform gracefully under pressure were still there. At one time I had struggled out of bed at 1 a.m. to climb a long, demanding route on a high peak before the afternoon thunderstorms struck; now I rose at the same ungodly hour to race the rising sun to a photogenic vantage point.

I quickly learned one of the fundamental paradoxes of landscape photography: the potential reward is always greatest when the odds against you are the longest. The most spectacular light often occurs when the rising or setting sun finds a tiny gap between dense clouds and the horizon. When that happens, you may have only seconds to compose the shot and capture the image. In many cases, such an opportunity will not occur again for weeks, or even months. One vicious hailstorm can flatten all the wildflowers in an entire valley. Miss a shot of fall foliage, and you may have to wait an entire year for another chance. The fall color display is always transitory; the leaves reach their peak of color just as the stems become so brittle that the slightest breeze sends them spinning to the ground. The most magical winter wonderland can endure to enchant photographers only briefly; all too soon, the sun and wind will erase all traces of the snow from the trees, and the world will become ordinary once more.

When I first became a full-time landscape photographer in 1993, the only way to share these marvelous moments was to capture them on film. In the film era, people assumed that an image was a representation of the real world unless proven otherwise. Today, in the digital era, peoples' perception of photographs has changed: many people assume a digital image has been modified unless proven otherwise. Given my reverence and respect for wild

▸ Longs Peak and Chasm Lake at sunrise, Rocky Mountain National Park, Colorado

▲ Uncompahgre Peak and the valley of the East Fork of the Cimarron River from Mt. Jackson, Uncompahgre Wilderness, Colorado

land, it probably goes without saying that I believe authenticity matters in landscape photography. For example, I had just one opportunity to photograph Comet Hale-Bopp, the brightest comet of the 20th century, setting over the Saber in Rocky Mountain National Park. I could have photographed the Saber on any moonlit night, then added Comet Hale-Bopp with a little digital magic in Photoshop, but what would have been the point? Even Hollywood knows that the truth has power, so it claims, whenever possible, that its latest movie is based on a true story. And while I could easily have fooled nearly all my viewers with a fake comet setting over the Saber, I would have been selling a lie.

Some people argue that images can never truly capture the real world, so any claim to authenticity is absurd. I readily acknowledge that there are significant differences between viewing the real world and viewing a photograph of it. Indeed, those differences are a major part of what this book is about. However, I believe it's possible to draw a line between an image that reflects reality in some fundamental way and one that doesn't. I want to be able to tell someone viewing my work, "What you see in my prints is what

I saw through the lens." I want the viewers of my work to exclaim, "Wow! What a magnificent world we live in!" not to think, "Wow, that guy really knows Photoshop."

From Peak Experience to Well-Crafted Image

To be a good landscape photographer, you need the heart of a hopeless romantic. But you also need the brain of a scientist and engineer. Creating an evocative landscape photograph requires both an emotional connection to the scene and an understanding of the science and craft of creating compelling images. My approach to learning landscape photography can be summed up in 10 words: master the science and craft, and the art will follow.

Understanding key scientific concepts from fields as diverse as geography, optics, vision, and psychology can help landscape photographers create captivating images. Mastering the science of landscape photography includes knowledge of atmospheric optics, the science of how sunlight interacts with our atmosphere. Atmospheric optics explains why the sky is often blue, sunsets are sometimes red, and why tall mountains rising abruptly above the plains can receive beautiful light. The ability to predict the appearance of spectacular light helps photographers be in the right place at the right time. Understanding the science of light also permits the knowledgeable photographer to predict where rainbows will appear and why polarizers sometimes enhance reflections and sometimes remove them.

The science also includes an understanding of how the complexities of human vision affect the way we see the world and the way we view art. For example, the brightest highlight in which our eyes can see detail is about 10,000 times brighter than the darkest shadow in which we can see detail. A photographic print can exhibit a range of light intensities of about 50 to 1, as opposed to the 10,000 to 1 we can see with our eyes. One of the fundamental problems for a landscape photographer is finding the best way to compress the very broad range of tones we see in the real world into the much narrower range of tones we can reproduce in a print. This book tackles this problem from many angles, starting with calculating exposure in the field and concluding with a variety of techniques in the digital darkroom. These techniques include the "Rembrandt Solution," a technique pioneered by the 17th-century master painter that is still relevant in the digital age. Used properly, the Rembrandt Solution can create the illusion of greater dynamic range in a print than what actually exists.

For a landscape photographer, the meaning of *craft* goes well beyond an understanding of photographic basics like aperture and shutter speed,

▲ 260-degree panorama at sunrise in January from the summit of 14,265-foot Quandary Peak, Tenmile Range, near Breckenridge, Colorado. The band of blue sky between the horizon and the band of pink sky is the twilight wedge.

focus point, and depth of field (the zone of sharpness from near to far). It includes the ability to locate promising subjects using topographic maps and computerized mapping tools. These computer programs help photographers visualize how light will play across the landscape and enable them to answer questions such as, "What is the best day in 2016 to photograph the full moon rising through Utah's world-famous Delicate Arch at sunset?"

▲ The full moon rising through Delicate Arch just before sunset, Arches National Park, Utah

Making images that capture your visual peak experiences and evoke emotion when you view them later is a satisfying achievement. To be truly successful as an artist, however, your images must speak to a wider audience. An understanding of the psychology of how we view art can strengthen your work. I'll discuss the distinction between images that are merely different and those that are genuinely creative. I'll also describe the critical importance of relevance, as demonstrated by research conducted with my images by advertising researcher Bruce Hall. As Robert Solso, author of *Cognition and The Visual Arts* put it, "An artist does not create art any more than a physicist creates physics." What he meant is that physicists don't invent the laws of physics; they try to uncover the laws that describe the seemingly chaotic phenomena they observe. Similarly, successful images aren't generated randomly; they must fit like a key in the lock on the viewer's emotions—triggering memories, evoking anticipation, and helping viewers imagine the feelings they would have experienced if they had been standing next to the photographer when the image was captured.

Before you can set out on your own personal vision quest, you need a working knowledge of your camera gear. In this book, I'll assume you're already familiar with the basic operation of your camera, such as how to

set the aperture and shutter speed to get what your in-camera meter considers to be the right exposure. You should be familiar with the various exposure modes your camera probably offers, such as program, aperture priority, shutter priority, and manual. You should know how to use exposure compensation to vary the exposure the sensor receives, and you should have a working knowledge of your camera's metering modes, which in modern cameras usually include center-weighted and multi-segment (called evaluative, matrix, or multi-pattern, depending on the manufacturer). Mid-level and better cameras often include spot metering as an additional metering mode; I'll discuss spot metering in detail in later chapters. I'll assume you know how to download images from your memory card and make basic adjustments to color and density with image-editing programs. A thorough reading of your instruction manual, plus a quick jaunt through a good basic volume on photography, should give you all the background you need to successfully use the information in this book.

I firmly believe that you do not need to be born an artist to create great photographs. In my view, landscape photography is largely a craft that can be mastered with practice. Noted black-and-white photographer John Sexton once said, "The only difference between me and my students is that I have made more mistakes than they have." There's a lot of truth in that statement. I shoot most of my images deep in the wilderness, but the lessons I've learned, and teach in this book, are equally applicable whether you're shooting sunset from the balcony of your home or shooting sunrise from the summit of a 14,000-foot peak. I hope that mastering the content of this book will give you the skills and knowledge you need to distill your own peak experiences into powerful images of the natural world.

▾ Sunrise light on the upper tier of Columbine Falls, Rocky Mountain National Park, Colorado

1

Landscape Photography Looks So Easy

Making a great landscape photograph seems simple. After all, a camera is just like your eye, right? Your eye has a lens that forms an image on your retina, which is how you see. A camera has a lens that forms an image on film or a digital sensor, and that becomes the photograph. What can be so hard? And yet I suspect that nearly all photographers have had this experience: you go hiking. You see something that moves you profoundly. You point the camera in exactly the same direction you were looking when you had that emotional experience and press the shutter release. Later you download the image to your computer so you can see it full-screen in all its glory, confident that you just made the best image of your career, and your reaction is, "Oh. I didn't think it would look like *that*." Why did the photo fail?

An anecdote here will give us a clue. A cataract is a defect of the eye that renders the lens opaque, so no light reaches the retina. At the beginning of the 20th century, eye surgeons developed a way to correct congenital cataracts. People who had been blind from birth suddenly, as adults, could "see." Or could they? They had a clear, sharp image falling on their retinas, but they were still functionally blind. They mistook shadows for solid objects; they couldn't recognize common objects when seen from unusual angles. They had trouble recognizing faces. Learning to read was often intensely difficult. Many gave up and resumed life as a blind person soon after the surgery. In one case, the patient could almost immediately recognize by sight some objects he had learned by touch while he was blind, but recognizing other objects was much more difficult. By itself, an image of an object formed on the retina is inherently ambiguous, since it could be a large object some distance away or a similarly shaped object that is much closer. An image can move across the retina because the object is in motion, the viewer is in motion, or both. The brain does a tremendous amount of processing on that flat, ambiguous image to create the perception of a stable, three-dimensional, emotionally meaningful world.

Clearly, the formation of an image on the retina is just the very beginning of seeing. In a similar way, making an evocative photograph involves a lot more than pointing the camera toward the subject and snapping the shutter—it must be an insightful, deliberate act. The photograph must provide all the visual clues necessary for the image to have impact.

So let's go back to the initial problem: you go for a hike, see something beautiful, snap the shutter, and the picture is a disappointment. Somehow

◂FIGURE 1-1 Jagged Mountain reflected in an unnamed lake, Weminuche Wilderness, Colorado

▲ FIGURE 1-2 Claret cup cactus and dwarf evening primrose, Salt Creek, Needles District, Canyonlands National Park, Utah

the experience of viewing the image on your monitor or in a print is not the same as viewing the real thing.

Viewing a Print vs. Viewing Reality

As I analyze it, there are seven ways in which viewing a print differs from viewing reality. Let's take each in turn.

1. Depth perception: We use many clues to figure out where things are in relation to other objects, both in a print and in reality. We use relative size: things look bigger when close than when far away. We use overlapping: if an object overlaps and partially obscures another object, the first object must be closer. We use the convergence of parallel lines: this is clearly seen, for example, in the way railroad tracks appear to converge in the distance. We use the pattern of light and shade: for example, we can only distinguish a sphere from a flat circle by the way sidelight reveals the sphere's three-dimensional form. We use atmospheric perspective: distant objects appear bluer, hazier, and a bit less sharp than closer ones. All of these depth clues operate both in the real world and in a photograph, but two crucial clues do not: binocular vision and motion parallax. Binocular vision simply means that we have two eyes, which see nearby objects from slightly different angles. The image formed by an object on our right retina is therefore slightly different from the image formed on the left. Our visual system fuses those two images and gives us the perception of depth. Motion parallax refers to the way the relative position of two objects changes when we move our heads. For example, two objects that overlapped may no longer overlap when we move and see the scene from a different angle.

Both binocular vision and the lack of motion parallax tell us instantly that a photographic print is flat. If we want to create the illusion of depth, which is usually desirable in a landscape photograph, we have to work very hard to maximize the remaining depth clues. Once you've had that initial emotional reaction to a scene and you decide to take a photograph, you have to slow down and consciously construct an image that will appear to have depth. You can't assume that the viewer will see depth in your print just because you saw depth while taking the picture. This may seem obvious—"Of course

prints are flat!"—but it's easy to forget this fact in the excitement of shooting the photo. I'll talk more about creating a sense of depth in chapter 5.

▲ FIGURE 1-3 Clearing storm over Mt. Alice, Rocky Mountain National Park, Colorado

2. Limited dynamic range: Our eyes can see a range of brightness, from brightest highlights to darkest shadows, that corresponds to about 13 to 14 f-stops. Transparency film is sensitive to a range of about five stops. Less expensive DSLRs can register maybe six stops. Both my Canon 1Ds Mark III and 5D Mark III can register 9 stops at the extreme limits. However, you can only get a range of about 5½ stops from any kind of print, whether inkjet or traditional wet darkroom. As I mentioned in the introduction, one of the fundamental problems in landscape photography is learning how to compress the very broad range of tones we observe in the real world into the much narrower range of tones we can reproduce in a print. *You* can see rich, colorful detail in both the shadowed flowers at your feet and the glowing clouds at sunset, but your *sensor* probably can't. If you don't take the limited dynamic range of your sensor into account, you may find that your highlights have washed out and your shadows have gone black. We'll tackle this problem from a variety of directions in chapters 6 and 7.

3. Limited sensory input: You can't smell the flowers in a photograph. When you're standing there in the field, all your senses are working, not just your vision. You can hear the birds singing and feel the warmth of the sun and the cool freshness of the wind on your face. You can hardly ignore the ache in your legs after hiking for hours to that scenic overlook. The viewer of your print can only use their vision to take in the scene, which means the visual content must be very strong all by itself to convey the emotion you felt while taking the picture. When you are standing there composing the photograph,

you need to consciously block out all the nonvisual sensations and ask yourself if the image you see through your viewfinder can create the effect you desire all by itself.

◂ FIGURE 1-4 Columbine in Ruby Basin at sunset, with Ruby Lake and the Twilight Peaks in the distance, Weminuche Wilderness, Colorado

4. Brightness constancy: Your eyes have a property called brightness constancy. Brightness constancy is the ability of your brain to see objects as having the same brightness regardless of the level of ambient illumination, so long as the ratio of brightness values in the scene is constant. For example, your eyes see snow as a bright white, or something pretty close to white, regardless of the brightness of the ambient light. Obviously cameras have exposure meters to vary the exposure depending on the level of ambient illumination. Most of the time those meters work pretty well. However, in the case of snow, they can fail without some conscious input from the photographer. Meters are designed to measure the brightness of scenes that reflect an average of 18 percent of the light falling on them, and then to expose those scenes "properly," which, to the camera, means a medium brightness midtone, or, in black-and-white terms, a middle gray. New-fallen snow, however, can reflect 90 percent of the light falling on it. Trusting your in-camera meter when photographing snow will result in gray, midtone snow. Since

▾ FIGURE 1-5 Looking south from the summit of 14,018-foot Pyramid Peak at sunrise, Maroon Bells-Snowmass Wilderness, Colorado

▲ FIGURE 1-6 Chair Mountain from Huntsman Ridge, proposed Hayes Creek wilderness area, White River National Forest, Colorado

snow is normally about two stops brighter than rock, everything else in the scene, such as rocks, trees, and your friend's face, will be underexposed by two stops.

Your eye easily compensates for the varying brightness of the light falling on snow when viewing the real thing, but will not make the same correction when viewing a print of snow if the snow is grossly underexposed because your eye calibrates itself to the average illumination in the room where you're viewing the print. For your eye to perceive the snow in the print as being white instead of gray, about four times as much light has to be reflected off of it than the midtone wood paneling of the wall where the print is hung. In other words, your visual system will perform corrections on the real scene that it will not perform when viewing a print. You never see medium-gray snow in the real world, but it's quite easy to see medium-gray snow in a photograph. That gives us a clue how to expose snow: take the lightest tone and make it white. In other words, meter the brightest snow and open up about two stops. This is another topic we'll revisit in much greater depth in chapters 6 and 7.

5. Color constancy: Our eyes do not see color the same way that a camera's sensor does. Both sensors and our eyes are sensitive to light with a wavelength between 400 and 700 nanometers. Sensors see color in a perfectly straightforward way: light of 700 nanometers is recorded as red, while light of 400 nanometers is recorded as violet (not purple). Light of other wavelengths is recorded as the colors in between. Our visual system does not see color this way. If it did, the colors of objects would appear to shift every time the color of the illumination shifted, from yellowish tungsten light to greenish fluorescent light to red sunrise light to white noon daylight. Our visual system actually constructs color in two ways: first, by comparing the wavelengths of light coming from different parts of the scene; and second, by comparing what we are seeing to our internal database of what we know the colors should be. We tend to accept the overall color of the scene's illumination as white, regardless of the actual color of light, so we see a white sheet of paper as white regardless of the color of the illumination. This is called color constancy.

Color constancy is something to guard against when you are photographing a subject that is in the shade on a clear day. The light illuminating those shadows comes from the blue sky and will be rendered as intensely blue in your image. Photograph vivid yellow flowers or bright yellow aspen leaves in the shade on a clear day, and you'll get sickly greenish-yellow flowers

◂ FIGURE 1-7 King's crown and skunk cabbage, Cumberland Basin, La Plata Mountains, Colorado

and leaves. Your eyes will color-correct an object in the real world if everything in your field of view is lit by blue light, but they won't color-correct a photograph of that object because they are already calibrated to the ambient illumination of the room in which you are viewing the print. If you're shooting closeups, you can, of course, change the white balance setting on your camera to *shade* or *cloudy*. If you're shooting grand landscapes, however, where the background of your subject is lit by warm sunrise or sunset light and the foreground is in shade, changing the white balance may give the sunlit portion of the scene an odd colorcast.

Color constancy can also catch you off guard if you shoot a closeup of purple and blue flowers lit by direct sunrise light. Since everything in your

▼ FIGURE 1-8 Careful camera placement and composition let me emphasize the flowers and mountains while minimizing the gray talus in the mid-ground in this image of a clearing storm over the Needle Mountains, Weminuche Wilderness, Colorado

field of view is lit by warm light, your visual system tends to ignore the light's true color and see the flowers as if they were lit by relatively white light. Purplish-blue columbine can be rendered with such a strong magenta cast that you may wonder if you've just discovered a new species.

6. Clutter: We think that we see the world by taking it all in with one big gulp. Indeed, our peripheral vision has an enormous field of view: about 180 degrees left to right and about 130 degrees top to bottom. But that's not actually how we examine the world. We actually only see sharply in an extremely limited angle of view because the region of the retina where the receptors are small enough and packed densely enough to see sharply is very small. This region of the retina is called the fovea. Foveal vision has an angle of view of only one or two degrees. That's roughly equivalent to a 1000mm to 2000mm telephoto lens. When viewing the world, our eyes fixate on a point of interest for about 300 milliseconds or so, then jump to the next point of interest. Eye movements are very fast—perhaps 25 to 45 milliseconds—and no real perception occurs during the movement. Our eyes actually jump around constantly, pausing briefly at regions of interest and skipping everything else.

Cameras have no such ability. In other words, let's say you're standing at the edge of a field of wildflowers and there's a magnificent mountain, bathed in sunset light, rising above your head. Unless you consciously train yourself to do otherwise, your eyes will jump from flower to flower, skipping over all the greenery in between, and will then jump all the way up to the mountaintop. You may not realize that there are really only a few flowers at your feet and that boring gray talus fills the middle third of your picture. When you look at a print of the same scene, your visual system does not perform a similar decluttering. We still examine the print using saccadic eye movements, but the effect is different. One reason for this may be physiological: when viewing the real world, our eyes have to swing through a large arc to go from the flowers at our feet to the mountain high above. When viewing a typical print from a typical viewing distance, our eyes travel through a much smaller arc, allowing us to observe every detail. Another reason for this may be cultural. When we view a print, it is typically framed and hung on a wall. It is being presented to us as something worthy of close inspection, so we tend to look at it more carefully. Regardless of the reason, it is certainly true that our visual system will skip over clutter in the real world that it will not skip over in a photograph.

7. Focus: Our eyes focus and refocus so rapidly as we scan a scene that we are rarely conscious of the process. As a result, everything we see normally

looks sharp. (Okay, middle-aged photographers like me who wear glasses with progressive lenses might beg to disagree, but in general it's true.) A carelessly snapped photograph, however, may or may not have sufficient depth of field to create a convincing illusion of reality. Our eyes obviously cannot correct blurry areas of a photograph and make them sharp.

Clearly, creating an evocative landscape photograph is not as easy as it first appears. As we've all experienced, capturing what you *see* is easy—just put the camera to your eye and press the shutter release. Capturing what you *feel*, however, is harder. Hardest of all is capturing what you feel in such a clear and compelling manner that your image causes the viewer to experience the same emotion you felt when you took the photograph. That's when photography can become an art.

◂ FIGURE 1-9 Mount of the Holy Cross, Indian paintbrush and lupine, Shrine Ridge, near Vail Pass, White River National Forest, Colorado

FIGURE 2-1 *Maroon Peak from West Maroon Basin*, Maroon Bells-Snowmass Wilderness, Colorado

2

In Search of Extraordinary Landscapes

The basin surrounding the headwaters of the East Fork of the Crystal River, below Hasley and West Maroon Passes, holds the richest flower fields I've ever seen in Colorado. When I first visited this basin in the Maroon Bells-Snowmass Wilderness for a three-day backpacking trip in July 1999, I spent a lot of time walking past these incredible flower fields in the pouring rain, thinking, "I sure wish I could shoot that." I returned to the area in July 2001. For several days I explored the basin, dodged thunderstorms, and shot various groups of flowers. Finally I discovered a spectacular field of lupine and red and yellow Indian paintbrush a short distance below Hasley Pass. The famed Maroon Bells, twin 14,000-foot peaks, rose in the background. As storm clouds gathered to the west, I exposed half a dozen sheets of film with my Zone VI 4 × 5 field camera, then stashed the camera gear and bolted for camp as the sky darkened with ominous clouds. Shortly after reaching my tent, the skies opened and rain fell in torrents for three hours. The next morning, after a brief respite, the summer monsoon returned in earnest. I packed up camp and headed for home, happy that I had produced at least one image that captured West Maroon Basin's lush beauty. I called it *Maroon Peak from West Maroon Basin*.

As this anecdote shows, great landscape photography is often one percent inspiration and 99 percent perspiration. I spent two separate weeks in West Maroon Basin before I came up with my favorite image from the area. It's rarely productive to randomly select a trail and head out in the middle of the day in hopes of making a great photograph the instant you find a beautiful scene. You generally have to scout for these locations, which involves a lot of walking and looking. I spend much more time scouting than I do behind the camera actually clicking the shutter.

Some people like shooting intimate landscapes: closeups of flowers, beautiful little waterfalls and cascades, or interesting weathered trees. Intimate landscapes are fine, and I shoot them when I find them, but I am most interested in the grand wilderness landscape. When I'm scouting, I'm usually looking for a compelling foreground that integrates seamlessly with a strong mid-ground and background. I also pay close attention to the potential for great light. This chapter will teach you how to search for a striking subject, which is always your first task. Finding that subject, however, is only the beginning of creating an evocative image.

▲ FIGURE 2-2 I spent several days scouting Utah's Arches National Park before locating this view of the Fiery Furnace and the La Sal Mountains

You'll probably find that you produce your best images in areas that inspire you. For me, that often means the mountains of Colorado, my home state. For you, that may mean the serpentine sandstone canyons of the southwest or the imposing granite bluffs of the Maine seacoast. Perhaps you're interested in capturing the lush green serenity of the rainforests of the Pacific Northwest. As you search for subjects, whether halfway around the world or in your own backyard, let your emotional reaction to a scene be your starting point. Then apply the technical skills you'll learn in this book to craft an image that will evoke the same emotion in a receptive viewer.

A diligent photographer who lives near a beautiful area should always have better photos of that location than one who has to travel a long distance to visit. It's exciting and fun to go to new and far-flung locations on every trip, but repeat visits to a promising nearby site in every season often reveal new possibilities and result in better images. Many of my best images have been made in areas with which I'm intimately familiar. It takes time to get to know a place—to find the most beautiful lakes, impressive sea stacks, and lush meadows. It's usually much better to have three nights in a promising location than to have one night in three different locations. Thorough scouting can help you find secret pockets of summer wildflowers, colorful autumn maple groves, and intriguing formations of snow and ice in winter. Guidebooks, online resources, and magazine articles can help, of course, as can rangers or other land-management personnel, but there's no real substitute for logging miles in your hiking boots. I've often felt that I've walked 20 miles for every good shot I've managed to take. On some occasions I photograph from the road, but such drive-by shooting rarely produces truly fresh imagery.

Working close to home also makes it easy to return again and again to a special location until you capture the image that matches your vision. For example, I've always enjoyed the view of Longs Peak from Many Parks Curve, a pullout along Trail Ridge Road in Rocky Mountain National Park. At 14,259

feet, Longs Peak is the highest mountain in Rocky Mountain National Park and the only Fourteener north of I-70. The problem was that the view from the road had no interesting foreground. Then one day I noticed a rocky outcrop flanked by trees just a hundred yards below the road. By themselves, the outcrop and trees were uninteresting. But what if they were covered with newly fallen snow? And what if that white, reflective snow was lit by warm sunrise light?

I snowshoed down to the knoll, shot a compass bearing to the horizon at the point where the sun would rise on winter solstice, then checked the map. The foothills along the horizon were lower than Many Parks Curve,

▲ FIGURE 2-3 I spent over a week in this area during three trips spanning several years before making this image of columbine and roseroot in Silver Creek Basin, Maroon Bells-Snowmass Wilderness, Colorado

which meant that my foreground would get light at the moment of sunrise, when the light was warmest. If the foothills had been higher, the sun would have had to rise over those obstacles and the light reaching my foreground would have been white. I shot a second bearing to Longs Peak, then calculated the difference: 54 degrees. I'd need my widest 4×5 lens, a 72mm optic with an angle of view of 77 degrees, to span the gap comfortably and give Longs Peak and the rising sun "room to breathe" inside the composition. As I envisioned it, the left side of the frame would show the rising sun through a gap in the snow-laden trees, while Longs Peak would dominate the right side of the frame. I'd need a wet snow near winter solstice and light winds so the snow wouldn't be blown out of the trees. Ideally the storm would end at night, leaving a clear dawn. If the storm cleared midday, the sun could easily melt the snow out of the trees before sunrise the next day. It took several years and several failures before all the elements came together, but when they finally did, I was able to make the image I call *Longs Peak from Many Parks Curve*.

A good landscape photographer is also a good naturalist. That means understanding the seasonal changes in the area where you're shooting. In the Colorado Rockies, for example, the first tundra flowers appear in early June, but the most showy tundra flowers, the alpine sunflowers, don't appear until late June or early July. The columbine, Indian paintbrush, and heartleaf arnica usually peak in mid- to late July. A heavy snow year can delay the cycle by weeks. Not all flowers bloom every year. An exceptional year for alpine sunflowers, for example, is followed by several years when you're lucky to find even a handful of them. Shooting in areas close to your home helps you track the progression of the seasons and time your shoots to capture the peak of the bloom or the height of the fall color.

Reflections of a scene off the surface of a body of water are another subject where it's helpful to shoot close to home, since it may take many visits to find a day of complete calm, when the reflection is most mirror-like. Often the wind is calmest right at sunrise, before the heat of the sun has a chance to warm the air and start its turbulent daily dance. The smaller the body of water, the better the chance of a perfect reflection. If the main body of water is too rippled, look for coves along the shore that may be calmer. Outlets and inlets, where the water flows gently, freeze up last in the fall and open up first in the spring. Sometimes they can offer interesting possibilities. Even windy days can sometimes offer reflection shots if the pool of water is small enough. I once shot a reflection on a day so windy I could hardly stand up. The strong wind was creating waves that, at irregular intervals, would push water up through a hole in an ice patch near shore to form a tiny, temporary pool that would calm down almost instantly when the wind lulled. By

shooting in the lulls when the pool was full of water, I was able to capture a good reflection. Trying to shoot a reflection in the main body of water, which was ice-free, would have been hopeless since the wind never stopped long enough to allow the whole lake to become still.

▲ FIGURE 2-4 *Longs Peak from Many Parks Curve,* Rocky Mountain National Park, Colorado

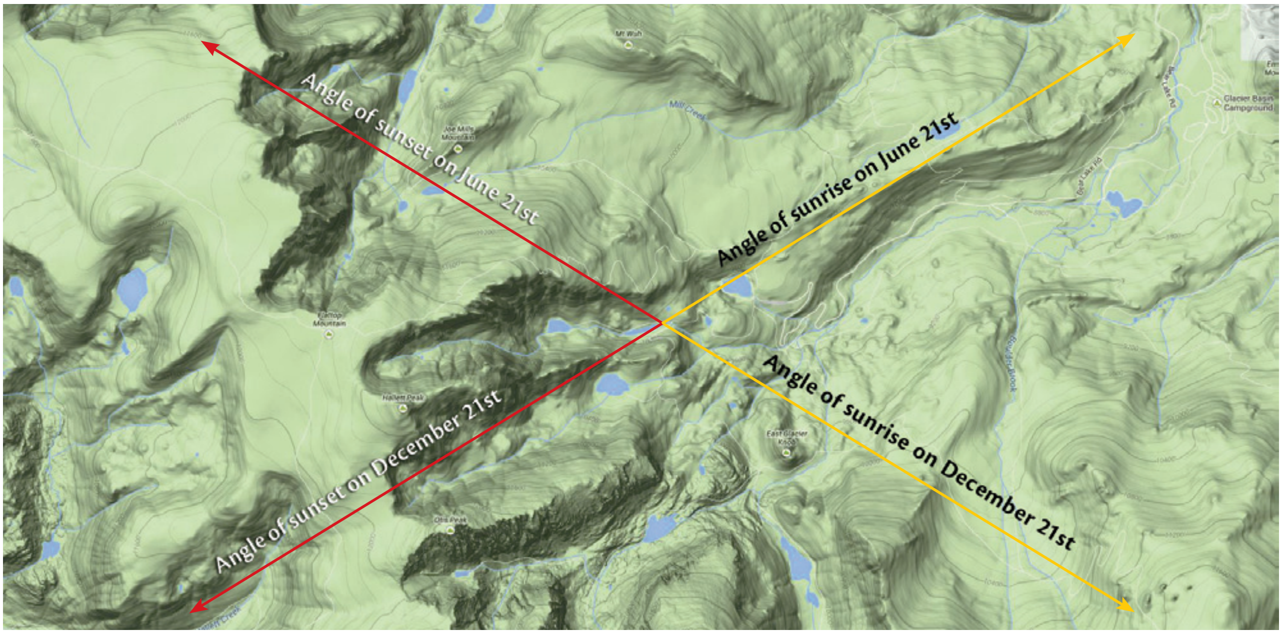
▲ FIGURE 2-5 Longs Peak and Glacier Gorge from Bear Lake at sunset, Rocky Mountain National Park, Colorado. It took many tries before I captured this combination of a sharp reflection, shapely clouds, and sunset light.

When scouting for flowers, remember that density trumps breadth. In other words, you're usually better off shooting a small but dense group of flowers, perhaps only a foot or two across, than you are shooting a broader, but less dense, grouping. No matter how dense the cluster of flowers, composing a grand landscape that includes the background is challenging if they are growing on a steep slope. If you try to shoot them from a position uphill from the flowers, looking straight down the slope, you have to place the tripod extremely low to the ground and use a very wide-angle lens to include both flowers and distant peaks. Usually the result of using such a wide angle is that the distant peaks shrink into insignificance and the (often-boring) mid-ground valley looms too large. If you shoot from below, looking straight up the slope, you lose the sense of perspective. Often the hillside looks flat, with very foreshortened peaks or crags at the top. Every picture element seems to lie in one plane, which reduces visual interest. Shooting across a steep slope is usually the best bet, but you can still easily end up with a region that lacks visual interest in the bottom corner of the frame closest to the flowers.

Keep other seasons in mind as you're scouting. A shot that doesn't work well when you discover it may be superb with a different lighting angle at a different time of year. At the latitude of Boulder (40 degrees north), the angle of sunrise (and sunset) varies by more than 60 degrees from summer solstice, usually June 21st, to winter solstice, usually December 21st. To be precise, the angle of sunrise varies from 58 degrees to 120.6 degrees; the angle of sunset varies from 239.4 degrees to 302 degrees. That's a huge difference in the angle of light on your subject, as you can see in figure 2-7. I always carry a compass, a topographic map, and a printout of sunrise and sunset angles with me when I'm scouting. The first thing I do when I discover a promising subject is to use the compass to determine precisely where the sun will come up and where it will go down. I currently use a desktop application called Heavenly Opportunity (PC only) for this kind of printout, but you can find the same information in several places on the web and in various smart-phone apps.

◂ FIGURE 2-6 Golden peas and the Flatirons from Chautauqua, Boulder Mountain Parks, Colorado. This relatively small but dense group of flowers was more photogenic than broader but less dense groups of flowers nearby.

Here's an illustration of this approach. Once while hiking with my wife, Cora, in Colorado's Indian Peaks Wilderness in July, I came across a stream above Lake Isabelle and noticed that I could see the plains to the east through a notch in the foothills. Any time you're in the mountains and can see the plains either to the east or west, you've got potential for great light on your foreground. In this case, I envisioned warm sunrise light illuminating the stream as it flowed toward the rising sun. I shot a compass bearing to the notch and wrote the bearing down in the notebook I always carry. When I got home, I looked up when the sun would rise at the same bearing as the notch, and learned it would occur both in early September and mid-April. In mid-April the stream would still be snow-covered and frozen, but early



▲ FIGURE 2-7 This illustration, which is based on a screenshot from The Photographer's Ephemeris, shows how the angle of sunrise (and sunset) varies by more than 60 degrees from winter solstice to summer solstice at 40 degrees north latitude, the latitude of Boulder

▸ FIGURE 2-8 *Sunrise above Lake Isabelle,* Indian Peaks Wilderness, Colorado

September seemed promising. I returned twice that year and once again a year later before making my favorite image of this location, which I call *Sunrise above Lake Isabelle*. In addition to making notes on promising locations, it's extremely helpful to grab a few handheld compositional study frames to remind yourself what a location looks like. Even if you don't have your best camera with you, you can always take some shots with your phone.

Your primary task when scouting is to locate great foregrounds that integrate with superb backgrounds, but you should also keep a look out for new vantage points, whether they are 100 yards away or across the valley. Once while scouting the huge aspen groves along the road in the Kebler Pass area near Crested Butte, Colorado, I spotted a group of unusual red aspen high above the road at the base of Marcellina Mountain. I could have photographed the grove and Marcellina Mountain from the road, but I wondered if a better image was possible. I checked my topographic map, and saw that the grove had to be at an elevation of 8,600 feet. Examining the map further, I saw that there were no tall peaks between the grove and the point on the western horizon where the sun would set in late September. If the evening was clear, the red aspen would be bathed in orange light, which would create intense color in my shot. I could also tell from the map that the red aspen grove would offer a great view of 12,432-foot East Beckwith. I endured a skin-shredding bushwhack through steep Gambel oak thickets to reach the grove and confirm my theory, then repeated the trek that evening to take the shot, which I call *East Beckwith at Sunset*.

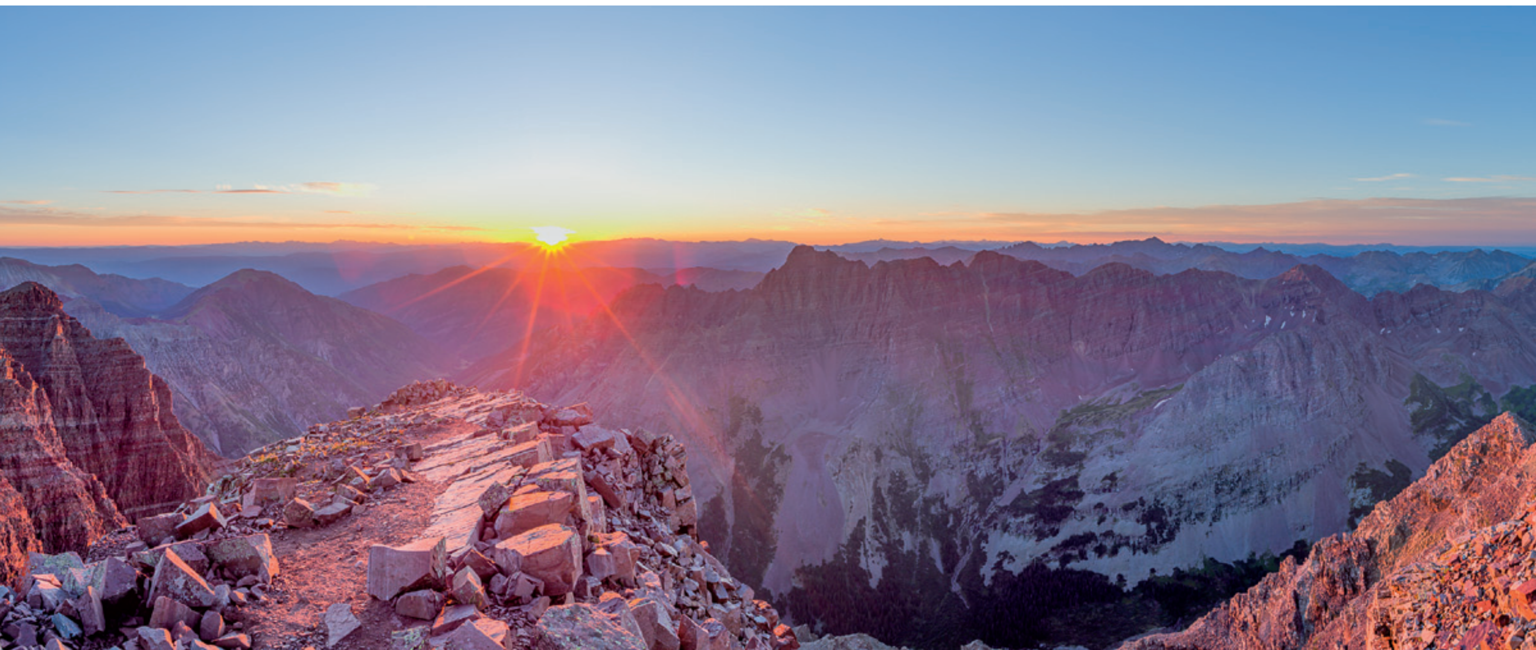
▲ FIGURE 2-9 *East Beckwith at Sunset*, Kebler Pass area, Colorado

▸ FIGURE 2-10 Sunrise panorama spanning 180 degrees, taken on the summit of South Maroon Peak, Maroon Bells-Snowmass Wilderness, Colorado. I left my campsite 4,000 feet below the summit at 11 p.m. and climbed for six hours in the dark in order to reach the top before sunrise.

As I'll detail in subsequent chapters, most good landscape photographs are made early or late in the day. The local geography determines whether the shot will work better at sunrise or sunset. The eastern slope of the Rockies near my home in Boulder, for example, tends to be a sunrise location because the most interesting sides of the peaks face east, toward the rising sun; at sunset they're in deep shade. Scouting sunrise shots is harder than scouting sunset ones. In the morning, you've got about half an hour between the time it's light enough to see and the time when you need to start setting up your camera. If an area is too big to scout in half an hour, you can't really scout a sunrise and shoot it effectively on the same day. You need to scout in advance, during the midday hours when the light is typically less interesting, then return at sunrise. Sunset shots are easier since you can conceivably scout and shoot on the same day—and you don't need to get up insanely early.

One of the dirty little secrets of landscape photography, especially landscapes in the wilderness, is that as fun and exciting as it can be, it's also a lot of hard work. I've often gotten up at 1 a.m. or 2 a.m. to be in the right place to shoot a sunrise. My motto for sunrise shoots is simple: sleep is for photographers who don't drink enough coffee. The earliest I've ever started was 11 p.m., which is when I left my camp at Crater Lake in the Maroon Bells-Snowmass Wilderness and started a six-hour climb up South Maroon Peak. I arrived on the summit 45 minutes before sunrise, in time to set up and shoot South Maroon Peak Panorama. (All these early starts have led me to formulate the first dictum in Randall's Rules of Landscape Photography: never eat breakfast before midnight. If you have to get up before midnight to do a photo shoot, eat dessert.)

Of course, if your subject is a long way from your camp or car, you'd better be prepared for some serious nighttime route finding and hiking. I carry a map, compass, altimeter, and GPS receiver, as well as a powerful



▲ FIGURE 2-11 Crestone Needle and the southern peaks of the Sangre de Cristo Range from the summit of 14,294-foot Crestone Peak at sunrise, Sangre de Cristo Wilderness, Colorado

LED headlamp with extra batteries. Since I'm frequently shooting alone, I also carry a tiny backup headlamp, complete with its own spare battery. For detailed treatises on backpacking and backcountry navigation, please see my books *Outward Bound Backpacker's Handbook* and *Outward Bound Map & Compass Handbook*, both published by Globe Pequot Press.

Getting to know an area also entails studying its weather patterns. A subject that is mundane under clear blue skies can be magical with the right *atmospherics:* the interplay of mist, fog, cloud, and landscape. In summer along the California coast, for example, fog develops almost every night and burns off again by noon. That transition, as the fog banks break up and the sun begins to spotlight the ground through holes in the clouds, can be a spectacular time to shoot. Almost everyone has felt their spirits lift as a gray day gives way to sunshine. A photograph that captures that feeling can be quite compelling. In the deserts of southern Utah, day after day of blue skies can result in images that all look the same. Landscape photographer Tom Till, who lives in Moab, the heart of red-rock country, told me his solution: "I wait for storms and go shoot when storms come." In winter that may mean the

rare significant snowfall; in summer that may mean waiting for the arrival of the summer monsoon, the annual influx of moist air that produces spectacular late-afternoon thunderstorms.

The transition from one weather system to another can produce unique images in mountain areas as well. Across the entire continental United States, most major storms track from west to east, following the prevailing winds. All winter long, these storms hammer Colorado's Continental Divide, particularly the Front Range, which includes the Indian Peaks Wilderness and Rocky Mountain National Park. The high winds scour the snow from the peaks and trees, leaving behind a stark landscape that's more harsh than beautiful. Occasionally, however, particularly in March and early April, these storms reverse course. Moist air pours in from the east, hits the foothills

▾ FIGURE 2-12 Longs Peak and Glacier Gorge from Bear Lake after an upslope snow, Rocky Mountain National Park, Colorado

▲ FIGURE 2-13 I have shot sunrise at Maroon Lake, in the Maroon Bells-Snowmass Wilderness, Colorado, at least a dozen times. This is the closest I've come to an ERNI—an exceptional rendition of a natural icon.

of the Rockies, rises and cools. These upslope storms sometimes dump as much as 20 or 30 inches of snow on the eastern side of the Continental Divide. Often these storms have light winds, so the snow plasters every peak and loads every tree, transforming the landscape overnight into a winter wonderland. I've learned to wait patiently for those days when upslope storms clear out, then do whatever it takes to be in the right place early in

the morning so I can shoot the scene before the sun melts the snow from the trees and the prevailing westerly winds reestablish themselves and begin scouring the peaks once more.

No matter where you're shooting, remember that in many ways bad weather can be good weather—particularly when you can combine it with good light. I'll explain why the day right after a storm can produce spectacular light in chapter 4.

Sometimes all your scouting will be for naught, and the best shot will turn out to be the one that's been staring you in the face all along. That's the case with the famous view of the Maroon Bells reflected in Maroon Lake. I once spent an entire day scouring the valley of Maroon Creek, hiking off-trail to the tops of obscure knolls, looking for that secret location that no one else had discovered. If it exists, I didn't find it. The best shot of the Maroon Bells is from Maroon Lake. So how do you create a fresh image of one of the most heavily photographed locations in Colorado? Shoot an ERNI: an exceptional rendition of a natural icon. Unless you're a lot luckier than I am, sometimes the only way to make something exceptional is to go back again and again until something interesting happens with the light, the clouds, and the atmospherics: a gathering or clearing storm, fresh snow, mist rising off the lake—something to lift the image from cliché to extraordinary.

This chapter has focused on the process of scouting broad areas that you've identified as promising. That's certainly a sound approach, but in some cases you can create photographs that are even more powerful by visualizing a specific image, then going out in search of the precise location that matches your vision. That's the subject of the next chapter.

FIGURE 3-1 I visualized this image, which I call *Aspen Panorama*, then went searching for a place where I could make a photograph to match my vision. I found the right spot near the South Mt. Elbert trailhead, San Isabel National Forest, Colorado.

3

Visualization

Truly great photographs often begin with visualization: imagining the best possible image a landscape could offer. Actualizing that image requires going out in search of the subject—and then going back again and again until you capture the light and atmospherics that match your vision. Here's an example:

I've always been fascinated by the wind-sculpted bones of timberline trees, particularly those snags that have been weathered to a wonderful golden hue. The trail up Twin Sisters, an 11,000-foot peak in Rocky Mountain National Park, leads past many splendid examples, but the background is always trees, not mountains. I visualized an image that would include both a spectacular tree and Longs Peak, which rises just a few miles southwest of Twin Sisters. In my imagined image, the tree would be bathed in golden sunrise light, which would accentuate the already warm tones in the wood.

No tree near the trail met all my criteria, so I began searching off-trail far to the south of the summit. After an hour of tough scrambling over several sub-summits, I found a golden-hued snag right on the ridge crest that permitted a spectacular view of Longs Peak. Unfortunately, there was a catch: a large tree growing directly to the east blocked sunrise light in the summer months. I shot a compass bearing to the horizon just beyond the extreme right edge of the tree. The compass read 115 degrees—a full 25 degrees south of due east. That meant the sun would have to rise at an angle of 115 degrees or farther south for the snag to get sunrise light.

When I got home I checked a sunrise-sunset table, which told me the weathered snag would only get sunrise light between November 20th and January 20th. The dead of winter is a tough time to reach a subject that requires a 3½-hour hike in the dark. I could have camped out, but the thought of crossing snow-covered talus with 80 pounds of winter camping gear and my 4×5 camera on my back made my knees tremble.

After months of procrastination, I decided to try to get the shot. I waited for a good weather forecast, then set my alarm for 1:30 a.m. My route lay along the western flank of a ridge, which meant I couldn't see the eastern horizon until I was just 100 yards from the tree. At last I popped over the ridge, looked

▲ FIGURE 3-2 Limber pine and Longs Peak, Rocky Mountain National Park, Colorado

east, and confronted a massive wall of clouds. There was no hope of sunrise light. I set up anyway, but the gray light was lifeless, and I put the camera away without exposing any film.

Two weeks later, just three days before January 20th, the last feasible day that winter to get the shot, I tried again. After 3½ hours of hard labor, I crested the ridge once more. The eastern horizon was clear. Pulse quickening, I hastily set up my equipment. Then I saw a band of clouds rolling in from the south. The moment of sunrise grew nearer. The clouds thickened and came closer. Scant minutes before sunrise, the clouds settled down over Longs Peak. Other clouds wafted silently across the eastern sky, blocking the light of the rising sun, and snow began to fall. I broke down the camera once again and started for home, exhausted, discouraged, and ready to give up for the year.

Two days later, right before the window of opportunity closed for that winter, I forced myself to check the weather forecast. It called for clear skies and moderate winds. Once again, I set my alarm for 1:30 a.m. This time the weather gods were with me. As the sun crested the horizon, its red light ignited the golden tones of the tree in front of me and washed over Longs Peak with a warm glow. I call the image *Fiery Limber Pine and Longs Peak*. Lucky, you say? Undoubtedly. But you can always improve your odds if you try again and again.

Using a Map to Help Visualize Photographs

Visualizing a great photograph always involves more than finding a suitable subject because the search for a great subject is inextricably intertwined with the search for great light. As I mentioned in the previous chapter, the most interesting light for a landscape photograph is often found near sunrise and sunset, when the warm rays of the sun enliven the colors and cast the long shadows that give the subject a three-dimensional feel when it is reduced to a two-dimensional image. Subjects that appear boring at midday can come alive as the sun sinks toward the horizon. But it's not enough to know that the best light usually occurs at the beginning and end of the day. You must also know if your subject ever *gets* interesting light.

Consider this example: Many of the most spectacular peaks in Rocky Mountain National Park ring the head of a deep, glacier-carved valley called Glacier Gorge. Unfortunately for the landscape photographer, the most arresting view of the gorge is looking due south, straight up the valley. In winter, all the peaks are backlit at both sunrise and sunset. Even in summer, Longs Peak shadows its lower neighbors to the west at sunrise, and McHenrys Peak shadows most of the peaks to the east at sunset. I've made

◂ FIGURE 3-3 *Fiery Limber Pine and Longs Peak,* Rocky Mountain National Park, Colorado

many photographs of Glacier Gorge, but none have spectacular light. In fact, the appeal of my only truly successful images of Glacier Gorge, such as *Bear Lake Sunrise*, rely more on the vibrant color of yellow fall aspen framing a blue foreground lake than they do on the light on the peaks.

The most fruitful places to search for great landscape subjects are those with the potential for great light. In mountainous country, that often means valleys whose mouths face either the rising or setting sun. For example, a valley running northeast at an angle of 60 or 70 degrees from its headwaters, roughly the angle of a midsummer sunrise, can work well during that season. On clear mornings, peaks and foreground subjects at the head of the valley can get beautiful sunrise light. Even better is a situation where the peaks at the head of the valley don't directly face the rising sun, but instead sit at a slight angle. That allows the warm light of sunrise to skim the surface

▾ FIGURE 3-4 *Bear Lake Sunrise,* Rocky Mountain National Park, Colorado

of the peak, casting interesting shadows that give the image depth and form. However, that same valley might present very few opportunities in the dead of winter when the sun is rising at an angle of roughly 120 degrees, leaving everything in deep blue shadow until hours after the sun has come up. Midday light on a clear day is typically harsh and colorless.

Once you've selected a potentially interesting valley, either by visiting the area or by studying a map, position a ruler on the map so that one end starts at the head of the valley, and the other end points toward sunrise or sunset. A protractor or a baseplate-style compass will help you position the ruler. Look for obstructions (nearby peaks or hills) that might block early light from reaching your subject. If the obstruction is the same height or lower, you're safe. If it's slightly higher, but the angular elevation to the obstacle is less than two degrees, the light will still be warm when it reaches your foreground, but it will have lost the intense coloration it can have at the moment of sunrise. At any greater of an angular elevation, the light can still provide interesting texture, but it will have lost nearly all of its color and will resemble the white light of midday. (I'll describe how to calculate angular elevations later in the chapter.)

You can use this same idea to determine how much of a peak will get light at the moment of sunrise or sunset. First determine the height of the highest ridge or peak that lies in the direction of sunrise or sunset. Then consult your topographic map: find the contour line *on the subject* that represents the height of that highest ridge or peak. Everything above that contour line should get warm light if the sky is clear at sunrise or sunset. For example, on August 1, sunrise light comes barreling up the valley of Tyndall Creek and bathes the northeast face of 12,713-foot Hallett Peak in a warm glow. The ridge to the east that the sun must clear to illuminate Hallett Peak is only 10,400 feet high, which means that the upper 2,300 feet of Hallett Peak get moment-of-sunrise light. Reflect that much warm light in the still waters of Dream Lake, and you've got an image like Figure 3-5, which I call *Dream Lake Reflection*.

It's rare that one location will work equally well at both sunrise and sunset. A valley that gets interesting light at sunrise will probably have peaks blocking the light of sunset. On the Pacific coast, sunsets are usually more interesting than sunrises (if the coastline at that point is running north-south). On the east coast, the opposite is usually true. In the wintertime, a peak or sandstone tower that's interesting when viewed from the south could be photogenic at both ends of the day since the south face could get both sunrise and sunset light if there are no obstructions. In winter, the sun rises well to the south of east and sets well to the south of west. Conversely, the north face of a peak can get light at both sunrise and sunset in summer

when the days are very long and the sun rises north of east and sets north of west.

▾ FIGURE 3-6 Cameron River below Cameron Falls at sunset, along the Ingraham Trail near Yellowknife, Northwest Territories, Canada. Sunsets in the Arctic can seem to last forever.

For an hour or so after sunrise and before sunset, the sun's path through the heavens forms an angle to the horizon that's roughly equal to 90 degrees minus your latitude. Imagine that the sun is drawing a line through the sky as it rises. If you're at 40 degrees north latitude, that line makes an angle of roughly 50 degrees to the horizon, leaning to the south, for the first hour or so after sunrise. This approximation works best in summer; the angle in winter is actually a bit lower. In the tropics, near latitude zero (the equator), the sun's path is nearly perpendicular to the horizon near the beginning and end of the day, which means that the periods of good light at sunrise and sunset are brief. In the high arctic, by contrast, the sun's path at sunrise and sunset is almost parallel to the horizon, and the good light can seem to last forever. Knowing the sun's path through the sky can prevent aggravating failures, like the time I tried to photograph sunrise above a frozen lake. Instead of rising over the end of the lake and bathing the rippled ice with warm, texturing light at the moment of sunrise as I expected, the sun followed a path that ran parallel to—and just barely below—a diagonally sloping ridge crest that began right at the end of the lake. It took 45 frustrating minutes for the sun to finally emerge from below the ridge. Needless to say, I had already given up on my original idea for the photograph.

Topographic maps from the U.S. Geologic Survey in the 7.5 minute series are the gold standard for detail and accuracy, but even they can lead you astray on rare occasions.

◂ FIGURE 3-5 *Dream Lake Reflection,* Rocky Mountain National Park, Colorado

In September one year, as I was studying maps of the area near Owl Creek Pass in the San Juans, I noticed a small lake I'd never visited. Coyote Lake, as it was called, was only about three miles from the road. I envisioned a great shot of yellow aspen and dramatic peaks reflected in clear blue water. On a beautiful fall day I packed up for a sunset shoot and headed in.

A mile into the hike, the trail vanished completely. I recorded a waypoint with my GPS receiver so I could relocate the trail as I hiked back out in the dark, measured a compass course on the map, and pressed on through the trackless aspen grove. Soon I ran into another trail, which seemed to be heading in the right direction. Another mile, and I reached a trail junction. A sign pointed right toward the Coyote Lake Trail. Pulse quickening, I hurried on, keeping a close eye on my GPS receiver since the trail did not lead directly to the lake. At last the GPS unit told me the lake was just a hundred yards away up a steep embankment. Soon I crested the embankment, did a double take, and stopped.

▾ FIGURE 3-7 Coyote "Lake" was a bust, but I did eventually find a beautiful reflection at nearby Clear Lake, San Juan Mountains, Colorado

There was a small problem with my grand plan. Cows were grazing in the middle of Coyote Lake. No, these cows had not learned to walk on water. Coyote Lake was a meadow.

I checked the publication date on my map. It hadn't been field-checked in nearly 50 years. Coyote Lake had long ago filled up with silt and sprouted grass. The sight was so absurd I simply had to laugh. Then I turned around and hiked back out, pausing along the way to shoot sunset at a little knoll alongside the trail. At least I'd never shot from *that* vantage point before.

That fiasco taught me to add another tool to my visualization arsenal: Google Earth. When I got home, I compared satellite images from Google Earth to my topographic maps. Not only could I see that Coyote "Lake" was a meadow, I could also see that another nearby "lake" that looked promising but required an even longer approach had also become cow heaven. No need to waste a precious sunset shooting at that location!

Shooting Moonset at Sunrise

Computer programs like Heavenly Opportunity (and the numerous websites and smartphone apps with similar information) can tell you more than just the angle of sunrise and sunset. They also can help you with more difficult astronomical problems, such as predicting exactly where the moon will be at the moment of sunrise. Such programs can prevent fiascoes like the time Cora and I hiked to the summit of Twin Sisters to photograph the full moon setting over Longs Peak. I had visualized a shot where the full moon would be directly over the summit. I would use a long lens to fill the frame with Longs Peak, lit by red sunrise light; that long lens would also magnify the moon and render it large enough in the frame to play a significant role in the image.

When we reached the summit, we discovered that the moon was indeed low in the western sky, but it was far to the right of Longs' summit. When I put on a wide-angle lens to include both the moon and Longs Peak, the moon was rendered as a minuscule dot that looked like someone had poked a hole in the emulsion with a needle. Longs didn't look a whole lot bigger, and the peaks in between the moon and Longs were so small they looked like the skyline of an Iowa pasture. When I used a long lens to fill the frame with Longs Peak, the moon was completely out of the frame.

That blooper taught me that I needed to plan moonset shoots far more carefully. Heavenly Opportunity will give you both the azimuth (compass bearing) of the moon and its angular elevation above a level horizon for any location and any time of day. To shoot the moon setting over Longs Peak you need to know the day when the moon will be just barely above the *actual* horizon (the mountain skyline) and near the summit of Longs Peak at sunrise, as viewed from the summit of Twin Sisters.

I'm going to start by telling you how I originally solved this problem using tools that will never become obsolete. I'll then discuss a simpler way that relies on a very useful application called The Photographer's Ephemeris. Since computer programs come and go, I think it's useful to know both methods.

You need two pieces of information to get started. The first is the direction to Longs Peak from Twin Sisters. The second is the angular elevation of Longs Peak: in other words, how far up you must look to see the summit of Longs Peak when standing on the summit of Twin Sisters, which is about 3,000 feet lower.

First I measured a bearing from the summit of Twin Sisters to the summit of Longs Peak using a topographic map and baseplate-style compass. Essentially I measured the angle between a line pointing toward true north, which is always at the top of the map, and a line leading from Twin Sisters to Longs Peak. The bearing to the moon at the moment of sunrise has to be

▸ FIGURE 3-8 Full moon setting over Mt. Meeker and Longs Peak at sunrise as seen from the summit of Twin Sisters, Rocky Mountain National Park, Colorado

within a few degrees of the bearing to Longs Peak, or the moon will be out of the frame when shooting with a long lens. Then I needed to calculate, in degrees, the angular elevation of the summit of Longs Peak as seen from the summit of Twin Sisters. Nothing is level in the mountains, of course, so knowing the angular elevation of the moon above a level horizon is useless unless you also know the angular elevation of the actual horizon—in this case, the summit of Longs Peak.

Here's how to calculate the angular elevation of Longs Peak as seen from Twin Sisters: First, find the height difference between Longs Peak and Twin Sisters by subtracting the height of the shorter peak from the height of the

taller peak. I'll borrow a term from surveyors and call this elevation change the "rise." Then use a ruler to measure on the map the horizontal distance between the two summits. Convert inches on the map to feet on the ground using the map scale, found along the map's margins. For example, most USGS 7.5 minute quads use a scale of 1 inch on the map for every 2,000 feet on the ground. I'll call this distance the "run." Now you need an inexpensive scientific calculator or smart phone app that can calculate inverse tangents, (also called arctangents, sometimes abbreviated as "arctan"). On my calculator, calculating an inverse tangent is a simple matter of pressing the "inverse" button, then the "tangent" button. Divide the rise by the run, hit inverse tangent, and presto! You've got the angular elevation of the summit of Longs Peak as seen from the summit of Twin Sisters.

▾ FIGURE 3-9 I shot this photo of the full moon setting over Mt. Meeker when the moon was just one moon diameter above the summit. Two minutes later, the edge of the moon touched the horizon; two minutes after that, the moon was gone.

Now you have the two pieces of information you need to use Heavenly Opportunity or its equivalent to search for the best days to photograph the full moon over Longs Peak at the moment of sunrise. You're looking for the days that match two criteria: first, you need to find the days when the moon sets no more than an hour after sunrise (so the moon will be close to the horizon at the moment of sunrise); second, you need to find the days when the bearing to the moon at moonset will be very close to the bearing to Longs Peak. You can narrow your search by first identifying the days with a full moon, then looking at the following day or two. This approach will work for any peak, or in fact for any situation where you want the moon to appear in a particular location, such as inside an arch or between two rock pillars.

It's likely that only a few days each year will match both criteria. Does that mean every day on that list will work? Not quite. We're not really interested in where the moon will be at moonset—we're interested in where it will be at sunrise, when the light is beautiful. In this example, sunrise could be as much as an hour earlier than moonset. In the example of Longs Peak, not only must the moon be in the right position left to right so it's close to the summit, but it also must be far enough above the actual horizon (the mountain skyline) to still be visible at the moment of sunrise. For example, the angular elevation of Longs Peak as seen from Twin Sisters is 5 degrees. If the moon has an angular elevation of 2 degrees at sunrise, that day won't work because the moon will have already set behind Longs Peak when the sun comes up.

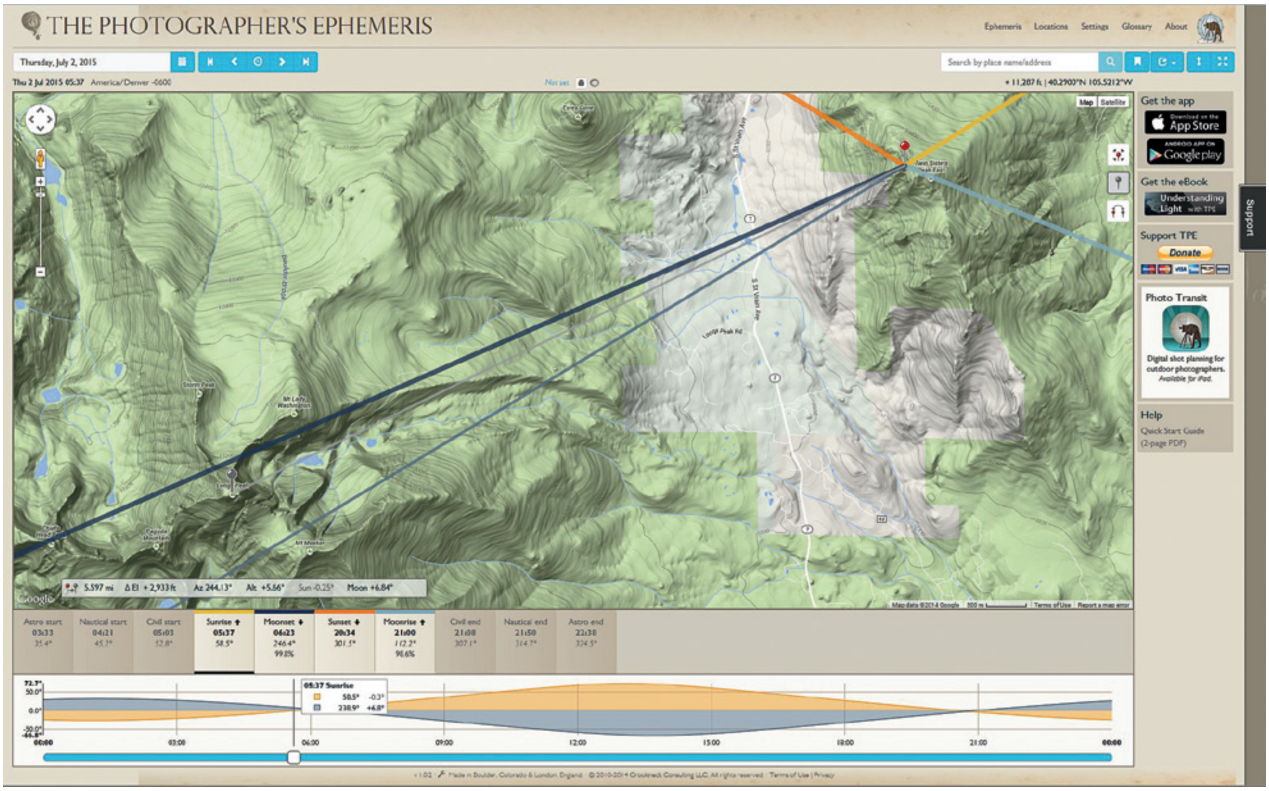
The moon subtends an angle of about half a degree. In other words, the angle between a line from your eye to the top of the moon and a line between your eye and the bottom of the moon is about half a degree. That's really quite small. To put that in perspective, the angle of view of a 50mm lens on a full-frame camera (measured on the long dimension) is about 40 degrees. Take a picture of the moon with a 50mm lens, and the moon will occupy only 1/80th of the width of the frame. Knowing this can help you visualize your shot. If the moon is 10 degrees—20 moon diameters—above the actual horizon at the moment of sunrise, you're going to have a lot of sky between the mountain and the moon. The moon itself will look very small when you use the normal-to-wide lens you'll need to include all that sky, plus the peak. Unless that sky is filled with colorful clouds, the shot probably won't be very interesting. On the other hand, if the moon is only a degree or two—two to four moon diameters—above the actual horizon, you can fill the frame with the mountain and a narrow strip of sky enlivened by the moon. The earth rotates 360 degrees every 24 hours, which means that the moon (and the sun) move one degree across the sky every four minutes, or about one moon diameter in two minutes. If the moon is only one moon diameter above the actual horizon at the moment of sunrise, you've got only a couple of minutes until it's gone for

▸ FIGURE 3-10 I used the technique described here to calculate the best day to shoot the full moon setting over Wetterhorn Peak as seen from the summit of Uncompahgre Peak, Uncompahgre Wilderness, Colorado

good. Knowing your lenses' fields of view (in degrees) will help you visualize the final shot. That information is readily available on the Internet.

The Photographer's Ephemeris, or similar programs available at the time you read this, can simplify the problem. The heart of TPE is a topographic map. The maps are derived from Google Maps, which means you need an Internet connection to make the program work. When the program opens, it displays a primary marker on the map. Four thick, color-coded lines radiate from the primary marker, indicating the direction to sunrise (yellow), sunset (orange), moonrise (light blue), and moonset (dark blue) on the day you choose. If the sun is above the horizon at the time you've chosen, a thin yellow line appears indicating the direction from the primary marker to the sun at that moment. If the moon is above the horizon, a thin blue line will

▸ FIGURE 3-11 I used a similar approach to calculate the best day to photograph the moon rising over the La Sal Mountains from Monument Basin, Canyonlands National Park, Utah



▲ FIGURE 3-12 The main screen in The Photographer's Ephemeris for July 2, 2015. The primary marker is positioned atop Twin Sisters; the secondary marker is positioned atop Longs Peak. The time is set for sunrise. Notice that the thin blue line indicating the direction of the moon as seen from the summit of Twin Sisters runs between Longs Peak and Mt. Meeker. The small box just above the timeline shows the distance from Twin Sisters to Longs Peak, the difference in elevation between the two summits, the azimuth (compass bearing) from Twin Sisters to Longs Peak, and the altitude (angular elevation) of Longs Peak as seen from Twin Sisters.

appear indicating the direction from the primary marker to the moon. In the case of photographing Longs Peak from Twin Sisters, you drag the primary marker to the summit of Twin Sisters, set the time to sunrise, and see where the moon will be at the moment of sunrise. Click the gray pin icon and a secondary marker appears. Drag the secondary marker to the summit of Longs Peak, and the software reads out the bearing of Longs Peak as well as its angular elevation.

That brief introduction to TPE is surely not enough to teach you every facet of the software. I find TPE invaluable when planning my shoots, but it may have vanished or changed beyond recognition by the time you read this book, so it would be inappropriate to spend too much time on it. If it or a better alternative is available, it would be well worth your time to download it and learn its many features.

I'd like to give you two more examples of how visualization can bring together subject and light to create a powerful image.

Each September in Colorado, as the days cool and shorten, the leaves of the aspen trees begin to turn from green to gold. As the fall of 1996 began, I tried to think of a fresh way to photograph the autumn splendor. What if

▲ FIGURE 3-13 Aspen leaves backlit by the rising or setting sun can produce intense color, as you can see in this sunset shot of Marcellina Mountain and the Raggeds, taken in the Kebler Pass region of Colorado

I could find a grove of aspen that was backlit at the moment of sunrise? The warm-toned light from the rising sun flooding through the leaves would surely make them glow like stained glass.

All the aspen groves I knew of grew deep in a valley. The sun didn't reach them until an hour or more after sunrise, when sunlight has already lost all its warm tone and become pure white. The first problem, then, was to find a grove of aspens that would get sunrise light.

I spent the next several days exploring Rocky Mountain National Park, hiking on-trail and off. On the third day I scouted a grove on the summit of Steep Mountain. No luck: the grove got sunrise light, but the aspen leaves turned out to be half rotten, half blown off, and an ugly black snag sat squarely in the midst of the best grove. Looking back north toward Beaver Mountain, however, I noticed a grove of aspens I'd never seen before. I checked the map, and found that this grove, too, would get sunrise light. The grove was thin, which meant the light from the sun could filter through and give me the stained-glass effect I was looking for. Had the grove been too thick, all the light from the sun would have been absorbed. A small clearing immediately uphill from the grove made it possible to get a clear view of the aspens. Without that clearing, my view of the trees would have been obstructed by conifers or solid rock. Unfortunately, the aspen grove lay well above the nearest trail.

A few days later, after a sleepless night taking care of my two-year-old daughter, Emily, and a failed sunrise shoot nearby, I tried to hike to the Beaver Mountain grove. I quickly discovered that my map was wrong; the actual trail was a third of a mile away from the marked trail. After finally figuring out where I really was using compass bearings and altimeter readings, I measured a course from my current location to the estimated position of the aspen grove and struck off through the woods.

Half an hour later, I was there. The situation was perfect: beautiful aspens very near their peak and a clear view to the plains of Colorado a hundred

miles or more to the east. I knew I had to return the next day, or risk losing the shot for an entire year. My heart sank when I arrived in the parking lot the next morning at 4 a.m. A strong, gusty wind was blowing, and it looked like clouds to the east would obscure the sun at the moment of sunrise. I knew I needed a calm morning to make a sharp image of the leaves. Of course, the wind could mean I wouldn't have to worry about that—there might not be any leaves left on the trees to shoot.

When I reached the grove 45 minutes before sunrise, the situation seemed hopeless. The leaves were intact, but entire branches were whipping back and forth in the wind. I debated whether it was even worthwhile to set up the camera, but summoned the energy to set up and wait. The clouds at the

▲ FIGURE 3-14 *Sunrise Aspen*, Rocky Mountain National Park, Colorado

▲ FIGURE 3-15 Comet Hale-Bopp setting over the Saber, Rocky Mountain National Park, Colorado

eastern horizon thickened. Even if the wind stopped, the chances of getting sunrise light seemed low. I checked my watch. The moment of sunrise came and went. Then, miraculously, the wind paused. The sun, just barely above the horizon, burst through a tiny gap in the clouds, backlighting the aspen like an orange searchlight. Two minutes later, the light show was over. The wind began roaring once again and the sun vanished into the clouds. I was shaking my head in awe as I packed up and headed down. That night a punishing snowstorm stripped off all the leaves, and the shot was gone for the year. *Sunrise Aspen*, as I called it, quickly became a best seller.

Here's a final example of the power of visualization. Comet Hale-Bopp, the "comet of the century," was the extraordinarily bright comet that was prominent in the night sky in March and April, 1997. Photographing it took a lot of planning and a lot of luck. I started by measuring the comet's compass bearing and angular elevation above the horizon shortly after sunset. Then I used a scientific calculator and a topographic map to determine where I could go to be looking in the right direction and looking up at just the right angle to see the comet setting over a dramatic skyline an hour after sunset. By carefully studying the map, I figured out that the comet should appear above the Saber, a sharp granite tower in Rocky Mountain National Park, shortly after dark.

Unfortunately, March and April are stormy months in the park, with high winds and frequent snowstorms. In mid-April, however, a strong ridge of high pressure moved over Colorado, giving one day of perfect weather. I drove to the park, hiked four miles from the trailhead to Sky Pond, set up, and waited. As the last glow of sunset vanished from the western horizon, the comet materialized in the darkening sky right where I had predicted it would. Then something happened that I hadn't planned, but should have: in a stroke of pure luck, the first-quarter moon rose in just the right position and threw just the right amount of light to put detail into the snowfields and rock towers. Without moonlight, the photograph would have failed. The Saber would have been a black silhouette that would have given no hint of the tower's impressive size. Full of excitement, I shot the photograph with an Olympus OM1 and Fuji Super G film. The next day the weather turned stormy again. By the time the skies cleared, the comet was setting before the moon rose. By the time the moon returned to the proper position a month later, the comet was gone. I had managed to make an image that could not possibly be repeated for at least 2,400 years.

Not every shot has to be visualized or even scouted. On rare occasions I've stumbled across an exquisite subject just as the right light and atmospherics came together, and I've then created a successful image of that scene. Far more often, however, my best images came about because I imagined them first and then found a way to put my vision onto film or, today, my digital sensor. To me, visualization is one of the most exciting and enjoyable parts of landscape photography. Imagination is infinite: let yours run wild, then follow where it leads.

FIGURE 4-1 Winter sunrise at Grand View Point, Island in the Sky, Canyonlands National Park, Utah

4

The Art and Science of Light

Many years ago, when my ambitions as a photographer greatly exceeded my skills, a friend and I went on a climbing trip to Arches National Park, a marvelous preserve in southeast Utah that has the greatest density of natural arches in the world. Unfortunately, my friend injured his shoulder on the first day. With our climbing plans abruptly canceled, I spent the next three days driving around to scenic overlooks and making photographs of various arches, quite convinced I was adding publishable images to my growing collection. I shot at 10 a.m., noon, 2 p.m.—it didn't seem to matter, since I was framing up such extraordinary stone formations in my viewfinder. I was awed by what I saw; surely the photographs I took would generate that same awe in those who viewed them.

Later, when my understanding of landscape photography had deepened considerably, I went back through my collection of Arches photographs and threw every single one away. What went wrong? Quite simply, the light was boring. I had paid no attention to the angle of light, its color, or whether it was bold and direct or soft and subtle. Not even the most unique natural arches in the country could retain much interest as photographs when handled that way. I had also ignored "photo-*graphics*," to borrow a term from nature photographer John Shaw. I had failed to see my subjects as they would appear on film: as lines, shapes, and colors on a two-dimensional surface. This idea and other aspects of composition—the art of arranging subject elements within the frame—will be discussed in detail in the next chapter.

▾ FIGURE 4-2 Attention to light and composition paid off in this sunrise view of sandstone fins in the Devils Garden, Arches National Park, Utah

We are constantly deluged with images of all kinds, including landscape images. Every nature lover in this country has seen dozens of pictures of the Maroon Bells and Delicate Arch. You may not know their names, but their distinctive forms would nonetheless be recognizable. We live in an image-saturated culture.

Humanity has not always lived this way. In the Middle Ages, "illuminated" (illustrated) books were rare and precious things, hand-copied by monks. The daguerreotype, the first really popular form of photography, was invented in 1839, but the process generated only one-of-a-kind originals that could not be reproduced. In fact, prior to the invention of the half-tone printing process in 1877, images could only be reproduced in quantity by laboriously hand-engraving the image on a wooden block, which was then used for printing. Newspapers began using photographs regularly late in the 1800s, and the image explosion really began. Our landscape images today

▾ FIGURE 4-3 Sunrise from Mt. Wuh, Rocky Mountain National Park, Colorado

must compete with the hundreds of thousands of images our viewers have already seen. My first Arches photographs would have stunned a European monk in the Middle Ages, who had never even seen a photograph, much less a photograph of Delicate Arch. They certainly wouldn't have interested a modern photo editor.

One way to make your images fresh and exciting is to seek out different views of old subjects, or to find new subjects altogether, as described in the previous two chapters. Another way is to seek out unique light, which can reveal a familiar subject in a new way or make an unfamiliar subject into something extraordinary.

▲ FIGURE 4-4 This example of frontlighting shows Chasm Lake and Longs Peak in mid-July after a heavy snow year, Rocky Mountain National Park, Colorado

Lighting Fundamentals

The basics of photographic lighting may already be familiar to you. Frontlighting, with the light coming from behind you as you look at the scene, tends to make the subject look flat. The part of our visual system that sees depth and identifies where objects are located in space is actually colorblind. It works on luminance values; in other words, it's a black-and-white system, which is why images need shadows to reveal shape and texture. Frontlighting generally only works if the color of the light itself is unusual.

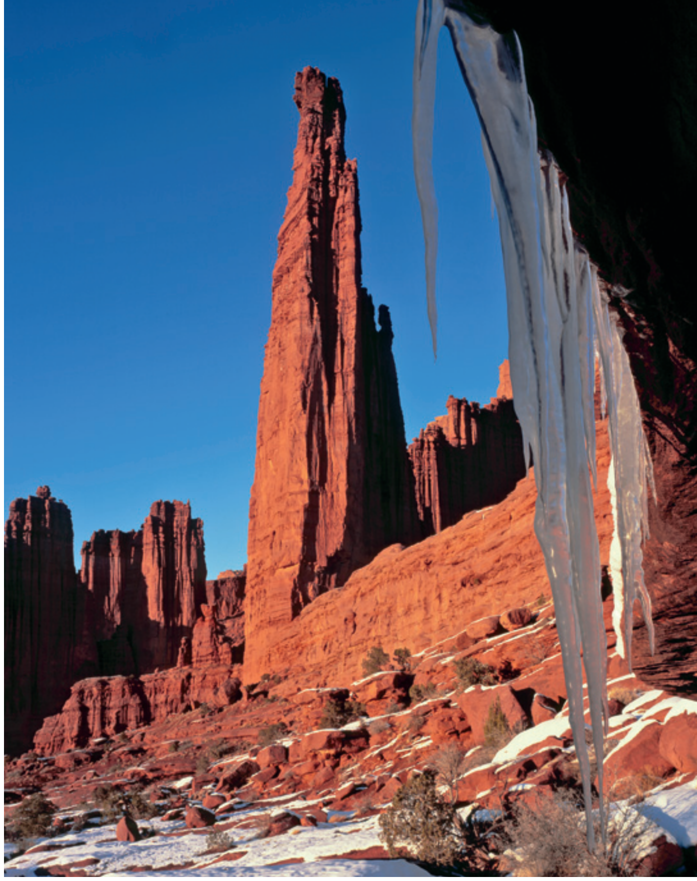
Sidelighting, with the light coming from the side of the subject, reveals the contours of the land with the interplay of light and shadow. Images shot in sidelight usually create a strong illusion of form and volume, which can make for powerful photographs. Sidelight is most effective when the sun is low in the sky because the shadows are long. When the sun is high in the sky, the shadows shorten, and the effect is much like frontlight.

Backlight, with the light coming from behind the subject, can add tremendous drama by rimlighting your subject or by creating a stained-glass effect as the light shines through flower petals or colorful autumn leaves. Backlight can also create a range in light intensities from deepest shadows to brightest highlights that exceeds the range your sensor can capture, making it one of the most difficult lighting situations to handle successfully. I'll describe how to meet this challenge in chapters 6 and 7.

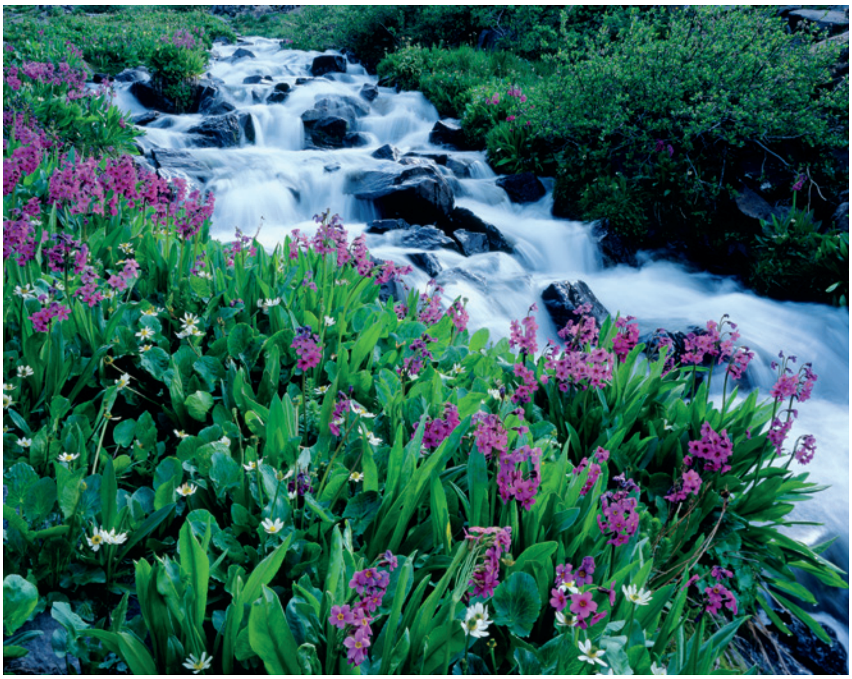
▸ FIGURE 4-5 Notice how sidelighting has brought out the rugged contours of Longs Peak in this view from Twin Sisters, Rocky Mountain National Park, Colorado

◂ FIGURE 4-6 Backlighting adds a dramatic glow to these Indian paintbrush below King Lake, Indian Peaks Wilderness, Colorado

The size of the light source also greatly affects your photograph's appearance. On a clear day the sun is a point source that casts strong, dark, hard-edged shadows. Such light works well for distant landscapes if the sun is fairly low in the sky and at 90 degrees to the subject. On a cloudy day your light source is the clouds themselves, which are lit from above by the sun. The light source is broad, so the lighting is even, with little difference between the soft-edged shadows and highlights. On an overcast day with thick clouds, the light is bluish in tone, which gives a photograph an overall cool, blue appearance. If the clouds are thin, however, the light is not only even, but white. Such lighting is effective for closeups of flowers and the like, since there are no harsh, distracting shadows, but it is neutral at best for broad landscapes, since it adds no interesting light to your subject. Grand landscapes can work in soft light if the foreground is very strong and colorful, the background features are rendered small in the frame, and the sky, which tends to record as blank white, is kept to an absolute minimum. I much prefer, however, to try to find grand landscapes where the background can get interesting light in its own right.



▴ FIGURE 4-7 The sun in a clear sky is a point source that casts strong shadows, as you can see in this image of Utah's Fisher Towers in January



◂ FIGURE 4-8 The soft light of an overcast day works well for intimate landscapes like this image of Parry's primroses growing alongside Cunningham Creek in the Weminuche Wilderness, Colorado

Blue Skies and Red Sunsets

Recognizing the direction and size of the light source is the first step, but there's far more to understanding natural light than that. How can it be, for example, that there's nothing blue in a blue sky, nor is there anything white in a white cloud? Why is it that the sky near the horizon opposite the sun can turn pink just before sunrise or after sunset, but only on exceptionally clear days when you are at the same elevation as your horizon? Why do rainbows never appear in level country if the shadow of your head is less than six feet away from your boots? The answers to these questions will tell you a lot about atmospheric optics, and understanding atmospheric optics will help you in your search for beautiful light.

If the earth had no atmosphere, there would be no colorful sunrises or sunsets. The sky would be black both day and night. Everyday objects would still be visible when the sun was above the horizon, but shadows would be lit only by sunlight bouncing off nearby surfaces. When the sun set, complete darkness would occur almost instantly. There would be no twilight. Light in a vacuum travels in a straight line, so without the atmosphere to deflect sun-

▾ FIGURE 4-9 If the earth had no atmosphere, we would never see colorful sunrises like the one I witnessed from the summit of La Plata Peak, San Isabel National Forest, Colorado

light from its straight-line path, no light could reach any objects once the sun dipped below the horizon because the earth would block the direct rays of the sun.

Fortunately for the landscape photographer (and for every living thing), the earth does have an atmosphere full of molecules of nitrogen, oxygen, and water (in vapor form), as well as dust and water droplets of all sizes. Let's divide these particles into three categories: those much smaller than the wavelength of visible light, such as molecules of nitrogen and oxygen; those that are roughly equal in size to the wavelength of light, such as some smoke particles; and those that are much larger, such as dust particles. Light's behavior when it strikes a particle depends on whether that particle is smaller or larger than the light's wavelength.

▲ FIGURE 4-10 On a clear day, particularly at high altitudes, the sky can be intensely blue, as seen in this image of the Maroon Bells, Maroon Bells-Snowmass Wilderness, Colorado

Before entering the earth's atmosphere, sunlight is composed of all the wavelengths of visible light. Different wavelengths correspond to different colors. We perceive the longest wavelengths of visible light, around 700 nanometers, as red; the shortest wavelengths, around 400 nanometers, we see as blue or violet. Mix together blue light, red light, and all the colors in between, and we see the mixture as white light.

As light travels through the atmosphere, it collides with various particles. If the particle is much smaller than the wavelength of light, such as a molecule of nitrogen or oxygen, the light is scattered in all directions: forward, backward, and, to a lesser extent, at right angles to the original direction of travel. In this type of scattering, called Rayleigh scattering, blue light is scattered much more effectively than red light. Some of the red light, in fact, passes straight through the atmosphere without being deflected from its original path. Particles about the size of the wavelength of light also scatter blue light more effectively than red light, but the effect is much less pronounced than it is for air molecules. Particles much larger than the wavelength of light, such as dust and water droplets, scatter all wavelengths equally, primarily in the forward direction, with most of the scattered light continuing in roughly the original direction of travel.

When you see a blue sky, you're actually seeing the blue component of the white sunlight that's been deflected from its original path by small particles in the atmosphere and has traveled down to your eyes. There's actually nothing blue in the sky in the sense that a blue sweater is blue. We see a blue sweater as blue because the sweater absorbs all the other colors of light and reflects the blue light to our eyes. The blue sky doesn't absorb the other colors; it simply doesn't scatter them down to our eyes as effectively.

You may have noticed that when you take pictures of yellow flowers or autumn leaves in the shade on a clear day, the vibrant colors your eye perceived have a greenish tint in the photograph. This is due to the color of the light illuminating the shade. The light doesn't come directly from the sun; your subject is in the shadows. Nor does it reflect off nearby objects, as many of my students guess. Instead, it comes from the sky, which is blue on a clear day. Rayleigh scattering causes the shadows on sunny days to be cooler in tone than areas illuminated directly by the sun; the light reaching the shadows comes primarily from the blue sky and has a pronounced blue tint. Put blue light on a yellow subject and you get a dull greenish-yellow hue. Shadows on snow on a sunny day are particularly bluish in tone because the white snow adds no color of its own. Rayleigh scattering is also responsible for the blue tint you see as you look at distant mountains. The Blue Ridge Mountains, which are part of the Appalachians, were so named because of this effect. Viewed close up, these mountains appear in their normal, midday colors. When viewed from far away, however, the light reaching your eye contains a mixture of light rays bouncing off the peaks and blue rays scattered toward you by the air between you and the mountains. The tendency of distant objects to look increasingly blue the farther away they are is called *aerial perspective*. Aerial perspective is one of the ways we judge distance.

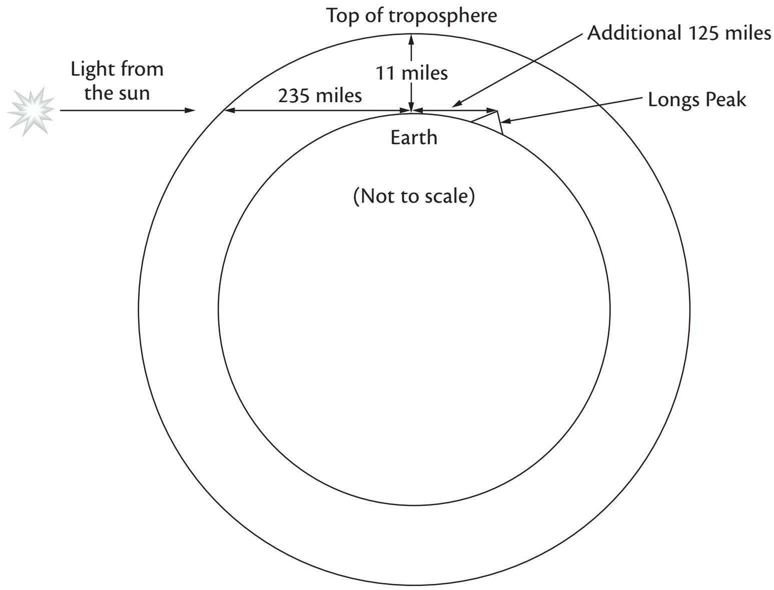
▾ FIGURE 4-11 Notice how the distant ridge is much bluer than the foreground ridge in this image of sunset from the summit of Ellingwood Peak, Sangre de Cristo Wilderness, Colorado

Now you know why the sky on a clear day is blue. So why are sunsets red? And why don't we see red clouds at noon?

The amount of Rayleigh scattering that occurs is dependent on the distance the light travels through the atmosphere. For the

sake of argument, I'll use the troposphere, the dense layer next to the earth, as a proxy for the atmosphere as a whole, since most scattering effects occur there.

At noon, the distance the light must travel through the troposphere is relatively short, roughly 11 miles. Enough blue light scatters out of the beam to make the sky blue, but the remaining light is still a mixture of wavelengths that we perceive as white. At sunrise and sunset, however, sunlight takes a much longer path because the light is traveling obliquely through the atmosphere along a tangent to the earth's surface rather than along a path nearly perpendicular to the earth's surface. For example, if you are photographing an old barn in eastern Colorado at sunrise, the path length through the troposphere is roughly 235 miles—20 times longer than at noon. At sunrise or sunset on a clear day, most of the blue light scatters out of the beam. The reddish light passes straight through the atmosphere, providing warm light on your subject. Snow and light-colored rocks show the true color of the light much more clearly than dark objects because they add no color of their own.



▲ FIGURE 4-12 The length of the path sunlight takes through the atmosphere varies throughout the day

This light scattering is also the reason for the brilliant red alpenglow sometimes seen on high peaks. The effect is particularly strong when tall mountains rise abruptly above the plains because the sun's rays take an exceptionally long path through the troposphere, first grazing the lowlands many miles from the peaks themselves, then slanting back up through the atmosphere to caress the highest summits with fiery light. Let's say you're photographing wind-sculpted snow on the summit of 14,259-foot Longs Peak, which rises abruptly above the plains 9,000 feet below. The path the light travels through the atmosphere will be even longer than it is for the eastern Colorado barn because sunlight has to enter the troposphere, skim the earth's surface somewhere near that barn, then continue through the atmosphere to the summit of Longs Peak—a total of roughly 360 miles, half again as long as the path to the barn alone. The exact numbers are not important, but the principle is: tall mountains that tower over nearby plains can get amazing light, as you can see in my image *Winter Sunrise on Longs Peak* (figure 4-13).

The same principles also explain why the sky near the zenith (the point directly above you) is usually darker at sunrise and sunset than the sky at the horizon, which is often distressingly bright. The sky at the zenith is darker because Rayleigh scattering causes most of the scattered light to continue in its original direction of travel or be scattered straight backward; only a relatively small amount of scattered light travels at a 90-degree angle to its original direction of travel. The sky at the zenith is also dark because you're looking through the thinnest possible layer of atmosphere at the blackness of space. Fewer molecules between you and the top of the atmosphere mean less light is scattered to your eyes overall, so you perceive the sky directly above you as darker than the sky viewed in any other direction.

That explains why the sky near the horizon is bright compared to the sky straight above, but why is it often whiter in tone? The color we see as we look at the horizon is a mixture of blue light scattered to our eyes from nearby air, and warm-toned light reaching our eyes from distant air. The length of the path the light follows from the most distant air near the horizon is so long that much of the blue light scatters out of the beam. The combined effect of the blue light from nearby air and redder light from distant air registers as white. This effect is stronger at sunrise and sunset than it is at midday. In fact, the sky near the horizon at sunrise and sunset can be so white and so bright that white clouds can actually appear darker by comparison—a reversal of the situation at midday, when white clouds are always brighter than the blue sky surrounding them.

By now you should know enough about atmospheric optics to understand why the sky is such a rich blue in *Winter Sunrise on Longs Peak* and so pale in *Indian Paintbrush and Capitol Peak*, which I shot at sunset. In *Winter Sunrise*, I was looking up very steeply at the darker sky well above the horizon, so the sky behind Longs Peak is dark blue. The blue sky contrasts vividly with the orange light on Longs Peak, and the photo jumps

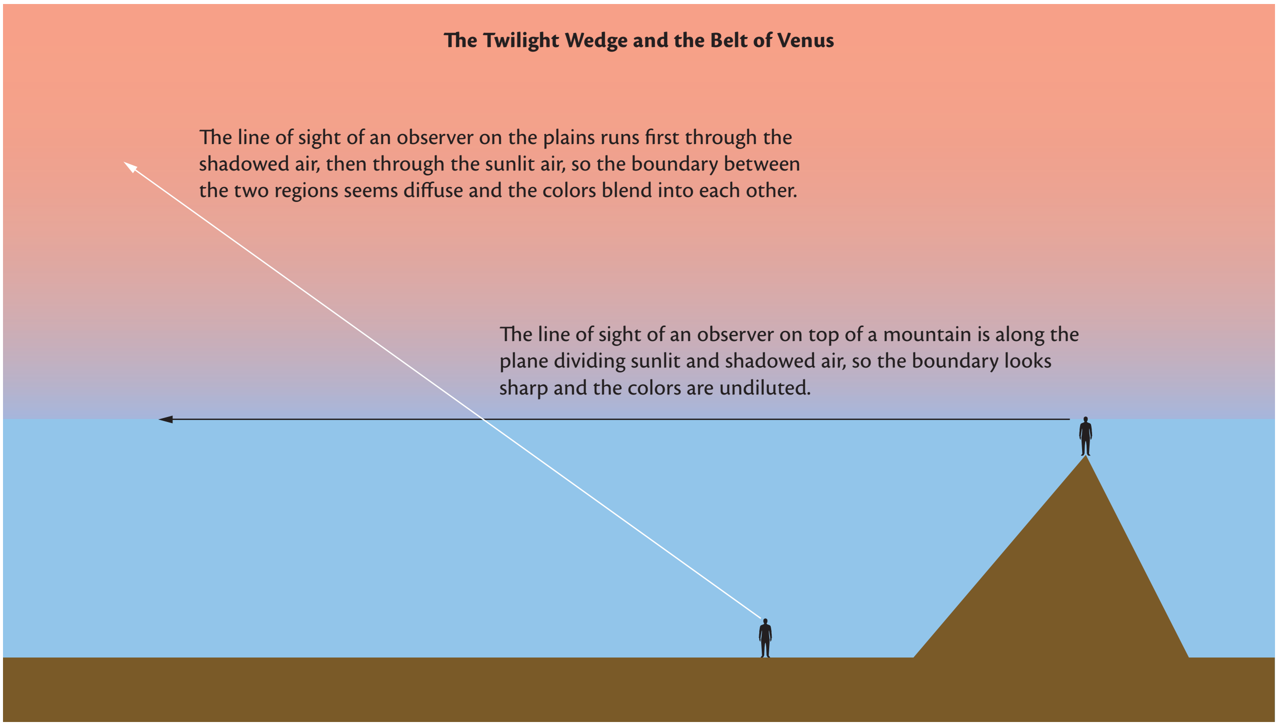
▾ FIGURE 4-14 *Indian Paintbrush and Capitol Peak,* Maroon Bells-Snowmass Wilderness, Colorado

◂ FIGURE 4-13 *Winter Sunrise on Longs Peak,* Rocky Mountain National Park, Colorado

off the page. In *Indian Paintbrush and Capitol Peak*, I was looking up only slightly at the bright sky near the horizon, so the sky is much paler. White skies in a landscape photograph are very distracting. In my view, this photo lacks the punch of *Winter Sunrise* because the bald sky draws your attention away from the brightly colored Indian paintbrush and the dramatic mountain. Understanding how sky color varies with time of day and the sun's angle above the horizon will help you scout locations to photograph because you will be better able to visualize the images each possible place can offer.

The red light from the sun at sunrise and sunset can light up more than clouds and peaks. It can also light up the air itself, causing the phenomenon known as the twilight wedge. It begins a few minutes before sunrise when a band of pink light, called the Belt of Venus, appears just above the horizon directly opposite the rising sun. The band of blue sky between the pink band and the horizon is actually the earth's shadow. As the sun rises, the band of pink light sinks toward the opposite horizon. The boundary between pink and blue sharpens and the pink color intensifies as it descends toward the earth. The pink light is usually at its strongest and most photogenic just before the last blue vanishes. A minute or two later, the sun strikes the tops

▾ FIGURE 4-15 The twilight wedge is most vivid on exceptionally clear mornings at high altitudes, as can be seen in this image of Mount of the Holy Cross from 14,286-foot Mt. Lincoln, Mosquito Range, Colorado



▲ FIGURE 4-16 The twilight wedge is most vivid at high altitudes

of the highest peaks and the sky at the horizon often becomes almost white. As the sun continues to rise, the light on the peaks fades from red to orange to yellow to white, and the sky at the horizon becomes pale blue. At sunset, the sequence plays out in reverse. You can see a dramatic example of the twilight wedge in my photo of Mount of the Holy Cross from Mt. Lincoln.

The twilight wedge is most photogenic on exceptionally clear mornings and evenings at high altitudes. When you're high in the mountains, your eyes are at nearly the same level as the plane that divides the shadowed blue air and pink sunlit air, so the boundary between the two seems sharp and the colors seem more pure. When viewed from the lowlands, however, particularly when the pink band is significantly above the horizon, your line of sight leads through the blue shadowed air first, then into the pink air. The boundary between the two colors seems blurred, and the pink tone is diluted.

White Clouds and White Haze

Now let's turn our attention to large-particle scattering. As I mentioned earlier, particles much larger than the wavelength of light scatter all wave-

▲ FIGURE 4-17 This photograph of Castle Peak in the Maroon Bells-Snowmass Wilderness, Colorado, was taken at sunrise, but thick haze killed the selective sorting of light that should have given me colorful alpenglow

lengths equally. The small water droplets that make up clouds are examples of these larger particles. That's why we see sunlit clouds at midday as white. There's nothing white in a white cloud; if you could examine a bit of cloud with a microscope, you would see only innumerable tiny, transparent water droplets.

Larger particles are also responsible for the white haze that can obscure the view of distant subjects. We see haze most clearly when looking in the direction of the sun, since large particles mostly scatter light forward in approximately the ray's original direction of travel. Photographing distant subjects when they're backlit on a hazy day is often futile. The visible side of a backlit subject is always in shadow. By definition, shadows are low contrast because there's little or no variation in the intensity of the light illuminating the shadowed region. If the atmosphere is hazy, contrast is reduced still further. Dark regions appear lighter than they should because some of the light coming from those areas is actually white light scattered by the haze between you and the subject. In severe cases, only the strongest possible contrasts (white snow against black rock, for instance) can still be seen. Ordinary subjects may appear completely monotone and void of detail. To make matters worse, the sky in the direction of the sun on a hazy day is glaringly bright, which means the sky is nearly certain to be rendered as blank white in your image.

The darkness of a blue sky is a good barometer of the cleanliness of the atmosphere and the probability of warm light at sunrise or sunset. On exceptionally clear days Rayleigh scattering is dominant, and the sky is a rich, deep blue. A light blue sky means larger particles are scattering white light to your eye, and the deep blue tint is diluted. The presence of larger particles also means the warm colors of sunset will be diluted by blue light scattering forward (rather than out of the beam), then bouncing back to your eye from your subject.

Color is not the only clue to the cleanliness of the atmosphere. Here's another rough-and-ready test: close one eye, then position your thumb over the sun with your arm outstretched so your thumb blocks direct light from the sun. (Never look directly at the sun! You can damage your eyesight.) On an exceptionally clear day, the sky adjacent to the sun will be almost the same shade of blue as the sky a handspan farther away. On a slightly hazy day, the sky adjacent to the sun will be much whiter (and brighter) than the sky a handspan farther away. On a really hazy day, the sky adjacent to the sun will be so blindingly bright you can't look at it.

If thick haze is shutting down your search for the grand landscape, do a rain dance. Water droplets often form around dust particles, which serve as

condensation nuclei. A hard rain temporarily washes the air clean of these dust particles, which is why the air seems so clear after a shower. That's one reason why bad weather can be good weather for a landscape photographer. The combination of a clearing storm and clean air can produce dramatic clouds ignited by richly colored light at sunrise or sunset.

▲ FIGURE 4-18 Clearing storm over the Sneffels Range at sunset, San Juan Mountains, Colorado

Scattering from larger particles isn't all bad. It's responsible for crepuscular rays, more often known as *god beams*. In the language of folklore, these columns of light in the sky are described as "the sun drawing water." We see crepuscular rays most commonly when light passes through a window into a dusty, darkened building. The beam of light is only visible because

▲ FIGURE 4-19 God beams (crepuscular rays) over Wilson Peak, San Juan Mountains, Colorado

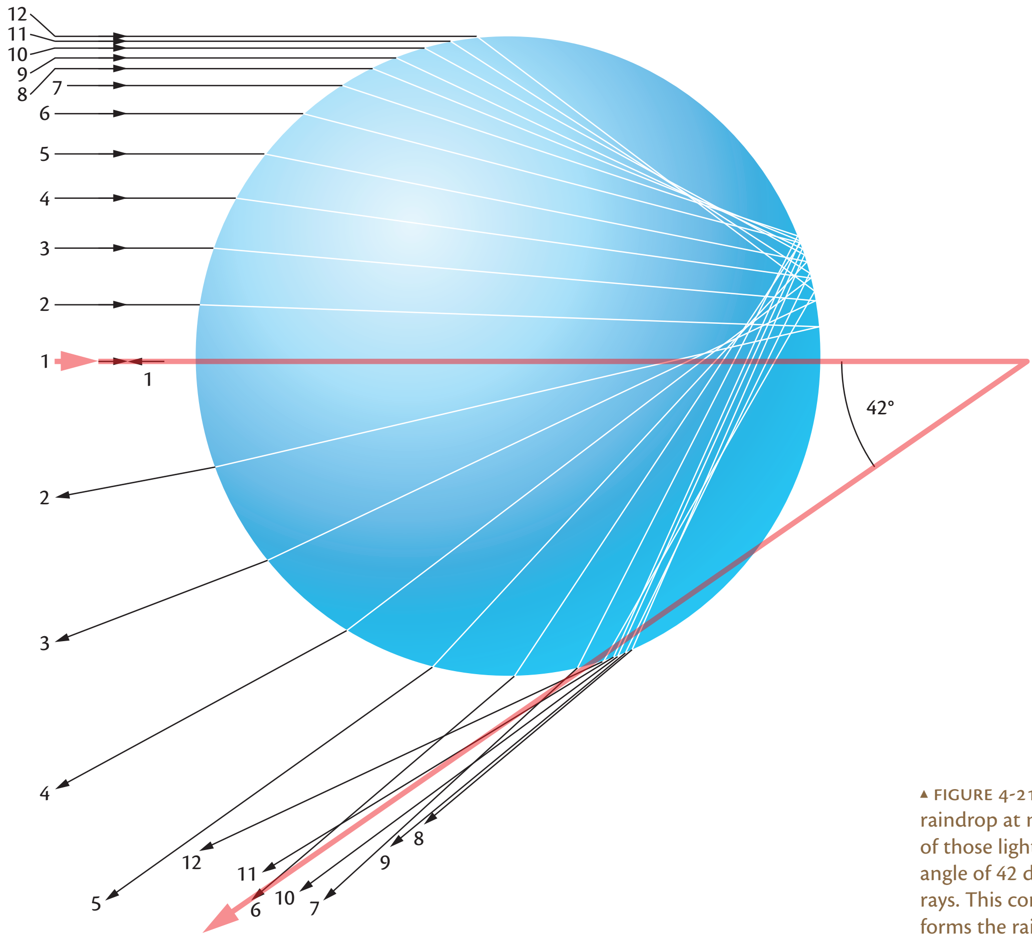
some of the light scatters out of the beam and reaches our eyes. Clear holes in dense clouds can also serve as "windows" producing the same effect. Sunlight passing through notches in serrated peaks when the sun is low can also create god beams. These beams appear to converge at the sun, which seems odd at first because the sun is so far from the earth that its rays are essentially parallel to each other. Crepuscular rays appear to converge for the same reason that parallel railroad tracks seem to converge at the horizon when we stand between the two rails. Anticrepuscular rays (anti-god beams? atheist beams?) are really just the continuation of crepuscular rays across the sky. They seem to converge at the antisolar point, the point in the sky directly opposite the sun.

Rainbows

The antisolar point plays a prominent role in an even more spectacular optical phenomenon: the rainbow. When I first began photographing seriously, I knew only that rainbows appeared when direct sunlight struck falling raindrops. That left me guessing where a rainbow might appear, or if one was even possible. A little studying soon taught me that rainbows are in fact quite predictable. To predict them yourself, you need to understand how rainbows form.

A falling raindrop is essentially spherical. When a ray of sunlight enters a drop, it bends slightly as it passes from air to water (a process called refraction), then reflects off the inside surface of the drop, and is refracted again as it exits the drop.

▼ FIGURE 4-20 Rainbow over the Dyke, Kebler Pass area, near Crested Butte, Colorado

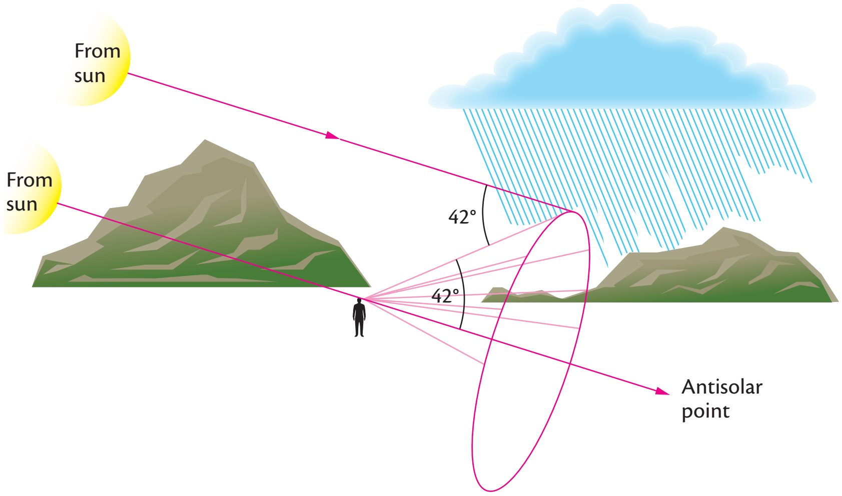


▲ FIGURE 4-21 Light rays enter the raindrop at many angles, but most of those light rays exit the drop at an angle of 42 degrees to the incoming rays. This concentration of rays forms the rainbow.

Rays can exit the drop at many angles, but the geometry of the sphere forces a large fraction of the rays to exit at nearly the same angle, around 42 degrees. This concentration of light reaching your eye from one direction forms the rainbow.

What then causes the beautiful colors? Each color of light corresponds to a different wavelength. The angle of refraction—the amount the ray bends as it enters and leaves the drop—varies depending on the wavelength. Red is bent the least; violet, at the other end of the visible spectrum, is bent the most. The result is that the arc of light reaching your eyes is separated into all the colors of the spectrum, just like what happens when sunlight is refracted through a prism.

The geometry of refraction and reflection dictate that a rainbow can only appear as a circle, centered on the antisolar point, with an angular radius of 42 degrees. Let's take that sentence apart and make sense of it one step at a time.



▸ FIGURE 4-22 Rainbows form in a circle, centered on the antisolar point, with an angular radius of 42 degrees

The rainbows we see most often are portions of a circle, with half or more of the arc cut off by the ground. If you saw a rainbow from an airplane, however, it could form a complete circle. That circle is centered on the antisolar point, which is the point directly opposite the sun. Imagine a line that starts at the sun and passes through your head. That line leads to the antisolar point. It's easy to identify the position of the antisolar point if the line intersects the ground: its position is marked by the shadow of your head.

Now comes the tricky part. Imagine a line from your eye to the antisolar point, and a second line from your eye to the rainbow. The angle between those two lines must always be 42 degrees. That's true whether you're measuring to where the rainbow intersects the horizon or measuring to the highest point on the rainbow's arc.

All this geometry leads to our first practical conclusion: rainbows can only appear when the sun's angular elevation is less than 42 degrees. Remember that the antisolar point is directly opposite the sun. If the sun is more than 42 degrees above the horizon, then the antisolar point must be more than 42 degrees below the horizon, which means the top of the rainbow would also be below the horizon. If the shadow of your head is less than five or six feet from your boots, then the sun must be higher than 42 degrees in the sky, and no rainbow can appear. Realistically, most rainbows worth photographing occur when the sun has an angular elevation of 25 degrees or less.

You can predict where a rainbow will appear with this simple trick. First, face your shadow. Stretch both arms in front of you with your fingers and thumbs spread as wide as possible and the tips of your thumbs touching, as shown in figure 4-23. Close one eye and place the tip of your left little finger on the shadow of your head. Now, while keeping the tip of your left little finger anchored on your head's shadow, scribe an imaginary arc in the air with the tip of your right little finger. For most people, that arc has an angular

radius of roughly 42 degrees. If a rainbow appears, it will occupy part or all of that arc. In level country, if the arc you scribe in the air lies below the horizon, then no rainbow can appear because the sun must be higher than 42 degrees. If the arc appears above the horizon, you can predict not only where the rainbow will intersect the horizon, but also how high the top of the arc will be above the horizon. In the mountains, of course, or in an airplane, rain can fall below you, and a rainbow can appear when the sun is at a higher angle. In a similar way, you can sometimes see a rainbow in the mist kicked up by a big waterfall if you're looking down on the falls from atop a nearby cliff.

▲ FIGURE 4-23 This simple trick lets you predict if a rainbow is possible, and, if possible, where it will appear

When the sunlight is strong and the curtain of rain is dense, a second, larger rainbow with an angular radius of 51 degrees can appear outside the primary bow. This secondary bow is caused by rays that enter the raindrops and are reflected twice before exiting. Rainbows can also be accompanied by interference or supernumerary bows, which appear most often just inside the primary arc. These thin, pale bows, most often alternating between light green and violet, are a consequence of the wave nature of light. Sometimes two waves enter the drop at different places but exit traveling in exactly the same direction toward the viewer's eye. If the crests of the waves coincide, the height of the wave—its intensity—is doubled. If a crest coincides with a trough, then the wave is annihilated, and less light reaches our eyes. Pairs of waves that enhance each other emerge from the drop at a

▸ FIGURE 4-24 Rainbow over aspens from Dallas Divide, Colorado, shot with a polarizing filter and an 80-200mm lens

▲ FIGURE 4-25 Rainbow over Cimarron Ridge and the Sneffels Range from Mt. Jackson, Uncompahgre National Forest, Colorado, shot with a polarizing filter and a 70–200mm lens

different angle than pairs of waves that cancel each other. The result can be the appearance of one or several bows inside the primary bow. The spacing between interference bows is dependent on the size of the droplets. If the curtain of rain is composed of many different sizes of drops, the interference bows all tend to overlap each other, making it impossible to distinguish one from another.

Whenever I encounter rainbow weather—sun near the horizon, clearing skies near the sun, a curtain of rain in the opposite direction—I use my hand-and-arm trick to trace out where a rainbow would appear, then start envisioning the best possible image I could make if the rainbow did materialize. Where would I stand? What would be the foreground? Rainbows, like the sun and moon, appear to move with you. Let's say the end of a rainbow terminates to the left of an old gold-miner's cabin. You want the rainbow to appear as if it were emanating from the cabin, so you move to the right. That causes the end of the rainbow to also move to the right until it is centered on the cabin.

Rainbow Position Chart

Sometimes, of course, clouds prevent you from seeing the shadow of your head, so the hand trick I described above won't work. Sometimes the best location for a rainbow photograph may be miles away, and you need to position yourself there well before the rainbow appears. In those cases, you can use a compass, a topographic map, a printout of sun positions during the day, and the chart below to predict the best places to chase rainbows.

Let's start with a bit more background information. A rainbow is a big subject, at least in an angular sense. If the rainbow's arc is a full half circle, then the width of the rainbow is 84 degrees (twice the angular radius of 42 degrees). That means you need a very wide lens—at least 20mm on a full-frame camera—to include the full arc. Although it's very exciting to see such a huge rainbow, all too often the result of photographing the entire arc is an image with a very thin half circle of color and a whole lot of boring gray sky underneath that arc. The angular distance from the inner to the outer edge of the rainbow is only about two degrees—a small fraction of the frame if the angle of view of your lens is 84 degrees or more. Many of the best rainbow images are shot with a telephoto lens and include only a portion of the arc, usually either the right or left limb where it intersects the horizon. To chase rainbows successfully, you need to know how to calculate where that intersection will be.

Here's a simplified example: Assume the sun is due west and about to set. Its bearing is 270 degrees. The antisolar point is directly opposite, or due east. Its bearing is 90 degrees. In level country, the right side of the rainbow will intersect the horizon at 132 degrees, 42 degrees to the right of the antisolar point (90 + 42 = 132). The left side of the rainbow will intersect the horizon at 48 degrees (90 – 42 = 48).

Armed with this information, you can now grab your map and start looking for interesting subjects. Once you've located a promising subject, you can hike or drive to a place where the bearing to the subject is either 132 degrees or 42 degrees. If a rainbow appears

▾ FIGURE 4-26 Rainbow near the peaks above Ophir, Uncompahgre National Forest, Colorado, shot with a polarizing filter and a 70-200mm lens

while you're at that location, the left limb will land on your subject if it's at a bearing of 42 degrees; the right limb will land on your subject if it's at a bearing of 132 degrees. In most cases, you'll want the rainbow arcing up and over the subject, curving into the frame, rather than curving out of it.

As I mentioned earlier, at a latitude of 40 degrees the angle of sunrise (and sunset) varies by 60 degrees from winter solstice to summer solstice. Rainbow weather most often occurs in summer in late afternoon, when the sun is setting well to the north of west. To calculate where the limbs of a rainbow will intersect the horizon at sunset when the sun is not setting straight west, find the angle of sunset for that date and location in a printout or phone app. Subtract 180 degrees from that angle to get the direction to the antisolar point. Add 42 degrees to the result to get the bearing to the right limb; subtract 42 degrees to get the bearing to the left limb. For example, if the sun is setting at an angle of 300 degrees, the antisolar point is at 120 degrees. The right limb will intersect the horizon at 162 degrees; the left limb will intersect the horizon at 78 degrees.

The situation is more complicated when the sun is well above the horizon but below the 42-degree angular limit above which no rainbow can be seen in level country. The table on the next page shows the angular distance from a point on the horizon directly opposite the sun to the intersection of a rainbow and the horizon for different sun elevations. To use the table, first find the compass bearing to the sun in your printout or app for the correct location and time of day. Subtract 180 degrees from that number to find the direction of the antisolar point. The antisolar point is actually below the horizon, but let's assume for the moment that it's right on the horizon. Find the angular elevation of the sun for the correct time of day and find the correct row in the table on the next page for that angular elevation. *Add* the number in the second column to the bearing (direction) of the antisolar point to determine the point where the right limb of the rainbow will intersect the horizon. *Subtract* the number in the second column from the bearing (direction) of the antisolar point to determine the point where the left limb of the rainbow will intersect the horizon. This assumes a level horizon, meaning one that has the same elevation as your location. The third column shows the altitude of the highest point of the rainbow above a level horizon.

Here's an example. Assume once again that the sun is due west, at a bearing of 270 degrees, but this time its altitude is 25 degrees. The antisolar point is actually 25 degrees below the horizon, but we will assume it's at the horizon. The bearing to this horizon antisolar point is 90 degrees. Consulting the table on the next page, you can see that the rainbow will intersect the horizon 35 degrees left and right of the horizon antisolar point, or at 125 and 65 degrees, respectively.

I used precisely this type of calculation to shoot *Rainbow over the Garden of Eden* in Arches National Park. It was rainbow weather, late afternoon, with brief, intense squalls followed by bursts of sunshine. I studied the map, looking for a scenic overlook where I would have an interesting subject at the right compass bearing so that a rainbow would arc up and over the subject. The Garden of Eden Overlook seemed promising. I drove there and waited. Sunset arrived, but clouds still blocked the sun, and I gave up hope of anything interesting happening. A minute later, the clouds parted and a rainbow appeared exactly where I had predicted it would.

Angular elevation in degrees of the sun above a level horizon	Angle from the point on the horizon directly opposite the sun to the intersection of the rainbow and the horizon	Angular elevation in degrees of the highest point of the rainbow, assuming a level horizon
40°	14°	2°
35°	25°	7°
30°	31°	12°
25°	35°	17°
20°	38°	22°
15°	40°	27°
10°	41°	32°
5°	42°	37°
0°	42°	42°

▾ FIGURE 4-27 *Rainbow over the Garden of Eden,* Arches National Park, Utah

Rainbows and Polarizers

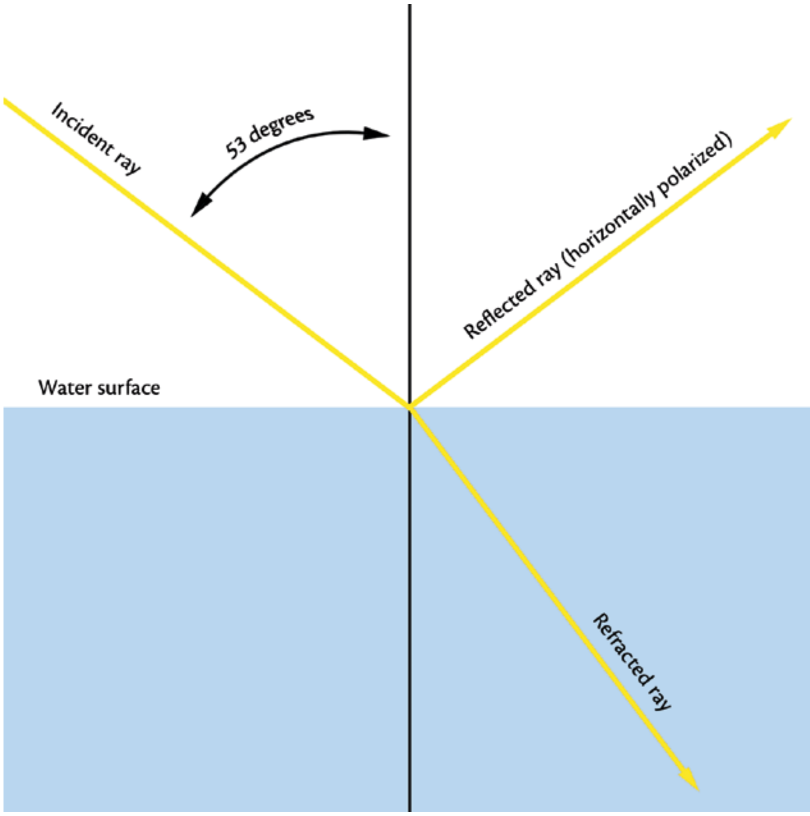
Rainbows are rare and fleeting, and their appearance is often startling. In psychological terms, they have *salience*, which means they often appear brighter and more vivid than they actually are. Salience is meaningless to a camera, of course, which is why photographs of rainbows sometimes disappoint. To make photographs of rainbows that capture the impact of what you saw, consider using a polarizing filter on an 80mm or longer lens. To understand why that filter and that focal length, you need to know a bit more about atmospheric optics.

Light can behave like both a particle and a wave. As a wave, light oscillates or vibrates in a certain plane, called the plane of polarization. Ordinary sunlight is a mixture of light with many different planes of polarization. A polarizing filter can be thought of as a picket fence with gaps between the fence slats. Orient the polarizer vertically, and it allows vertically polarized light to pass through the gaps. Orient it horizontally, and it blocks vertically polarized light. Light from the sky, when you look at a 90-degree angle to the sun, is vertically polarized. Orient your polarizer horizontally, and that blue sky will darken, both as seen through the viewfinder and in your image.

When light reflects from a water surface at a particular angle (called the Brewster angle), all horizontally polarized light is reflected. The remaining light is transmitted into the water. The situation is easiest to understand when considering reflections on the surface of a lake or pond. The Brewster angle for an air-water boundary is 53 degrees when measured from a line perpendicular to the water's surface, as shown in figure 4-28. If you are looking down at a steep angle to the surface of a pond, much of the light you see is horizontally polarized because it is reflected at an angle close to the Brewster angle. This explains why fishermen wear polarizing sunglasses with vertically oriented lenses that block the horizontally polarized reflected light. They want to see past the reflections on the water to spot the fish beneath the surface. Photographers can use polarizers for similar purposes, such as when shooting tide-pool creatures living below the surface.

On the other hand, if your line of sight forms a small angle with the surface of the water then the reflection off the water doesn't change the light's polarization. A polarizer will not remove reflections if the light is merely grazing the surface. As I mentioned earlier, light from the sky, when you are looking at 90 degrees to the sun, is vertically polarized. If the vertically polarized light from the sky is reflected at a shallow angle to the water's surface, it retains its original vertical polarization. A polarizer oriented horizontally will darken both the blue sky and the reflection of the blue sky in your image, as you can see in figure 4-29.

How does all this apply to rainbows? It turns out that the angle of reflection of light from the inside of a raindrop is close to the Brewster angle. That means that light from a rainbow is polarized. Light from the sky around the rainbow, however, has many different angles of polarization. Put a polarizer on your lens, orient it to permit the polarized rainbow light to come through, and you'll block the component of background light that has the opposite angle of polarization. By darkening the background, the rainbow appears brighter.



▲ FIGURE 4-28 All light reflected from a water surface at the Brewster angle (53 degrees measured from a line perpendicular to the water's surface) is horizontally polarized

So far, so good, but there's a catch. The angle of polarization of rainbow light is dependent on which segment of the rainbow you're photographing. Rainbow light is tangentially polarized, which means that the angle of polarization is along a line that is tangent to the arc of the rainbow (as shown in figure 4-30). Because a rainbow is curved, the angle of polarization varies. Put a polarizer on a wide-angle lens and you'll enhance one part of the rainbow while extinguishing another part. Rotate the polarizer and the situation will reverse, with the formerly brightened segment vanishing and the extinguished part reappearing. Put a polarizer on a short telephoto, however, perhaps an 80mm or so, and the situation is different. The telephoto has a much narrower angle of view than

◄ FIGURE 4-29 When I used a polarizer to darken both the blue sky and the sky's reflection in this image of a beaver pond near the South Mt. Elbert trailhead, San Isabel National Forest, Colorado, the effect seemed too strong, so I rotated the polarizer slightly to a partially effective setting

a wide-angle. The angle of polarization of the rainbow over that narrow angle of view is near constant. The polarizer, oriented properly, will enhance the entire segment of rainbow visible in your image. The result can be an image with the impact of the original experience.

▲ FIGURE 4-30 The light from a rainbow is tangentially polarized

The Rarest Light of All

I have been specializing in wilderness landscape photography for over 20 years. During that time, I've been privileged to photograph many beautiful scenes, but on only a dozen occasions have I witnessed the rarest light of all.

In my experience, truly extraordinary light occurs in two ways. In the first, the sun finds a narrow gap between dense clouds and the horizon precisely at the moment of sunrise or sunset. For just a minute —maybe only seconds—a beam of saturated light blasts through the gap and ignites the subject with the most colorful natural light you'll ever see. I call these images "gap" photos.

In the second situation, the sun, while still below the horizon, paints a broad bank of clouds with strongly colored light. These clouds, which can be inside the frame or out, now become the dominant light source. While glowing clouds are beautiful, of course, it is the light those clouds bounce down onto the landscape below that is truly remarkable. Like a giant soft box in the sky, the colorful clouds illuminate the landscape with a warm, soft, yet still directional light. These "glow" photographs seem to be suffused with an ethereal radiance.

Let's dig deeper into the principles behind these two situations, starting with gap photos. First, consider what happens during a cloudless sunrise. When the sky is clear, the colorful light coming directly from the rising sun is diluted by the bright, white light from the sky around the sun. It's like pouring white paint into red paint—the result is usually a pastel color that is pleasing but not extraordinary. If, however, the sun finds a gap between dense clouds and the horizon, the clouds block that bright, white light

▲ FIGURE 4-31 Cloudless sunrise at Columbine Falls, Rocky Mountain National Park, Colorado

▲ FIGURE 4-32 The sun found a gap between dense clouds and the horizon right at the moment of sunrise in this image of Columbine Falls, Rocky Mountain National Park, Colorado

from the sky around the sun and the result is some of the most spectacular light you'll ever see. If the sun is in the frame, the result can also be some of the highest-contrast light you'll ever encounter, which poses an exposure challenge. I'll talk in depth about meeting that challenge in chapters 6 and 7.

Now let's take a look at the atmospheric optics of glow photos, where a large bank of clouds lights up with such strong and colorful light that the clouds themselves become the dominant light source. First, consider what happens on a completely clear morning. When the sun is below the horizon, the blue sky is actually the dominant light source. Photographs taken under this lighting usually have inadequate contrast and a somber, cool cast. Photographs taken precisely at the moment of sunrise have a warm tone, with moderate contrast, but within a few minutes the contrast has strengthened dramatically, often too much so, and the light is basically white.

▲ FIGURE 4-33 A large bank of glowing clouds behind me created an ethereal glow in *Green River Overlook at Dawn*, Canyonlands National Park, Utah

▲ FIGURE 4-34 I shot *Green River Overlook at Sunrise*, Canyonlands National Park, Utah, just as direct sunlight first reached the tree

Glow photos, on the other hand, are warm in tone with soft (but not flat) contrast. Glow photos hit the perfect balance: enough contrast in the land to reveal form, but not so much contrast that your sensor has trouble straddling the difference in light intensities between highlights and shadows. Compare the two photos I call *Green River Overlook at Dawn* and *Green River Overlook at Sunrise*, as well as *Twilight Glow over Capitol Peak* and *Capitol Peak in Autumn*.

Exposure for the land portion of glow photos is easy, since the lighting is soft. The sky, however, can be very bright, particularly if the glowing clouds are in the frame. I'll discuss metering strategies for this kind of light in chapters 6 and 7.

Glow photos can occur almost anywhere. I've even seen a perceptible mauve glow in the depths of Colorado's aptly named Black Canyon of the Gunnison. All that's required is a sufficiently large bank of clouds lighting up brightly enough to overpower the light from the blue sky and any blue-gray clouds that remain in shadow. The glowing clouds then become the dominant light source.

Finding both gap and glow photos is a matter of luck, but there are ways to improve your odds. The first is to arrive early and stay late. The best glows often peak 15 to 30 minutes before sunrise or after sunset. I try to arrive at my shooting location 45 minutes to an hour before sunrise so I have time to

◂ FIGURE 4-35
The light source for *Twilight Glow Over Capitol Peak*, Maroon Bells-Snowmass Wilderness, Colorado, was a large mass of pink clouds out of the frame to the left

◂ FIGURE 4-36
Capitol Peak in Autumn, Maroon Bells-Snowmass Wilderness, Colorado. I shot this photo about 30 minutes after *Twilight Glow over Capitol Peak*.

get set up before the light gets interesting. At the other end of the day, I try not to cut and run the moment the sun dips below the horizon, particularly if there are clouds to the west that might light up.

A second way to improve your odds is persistence. Both kinds of photos, of course, depend on the presence of clouds. It's one of the paradoxes of landscape photography that widespread clouds both increase the risk of

getting skunked, and increase the odds that if you do get a photo, it will be a very good one. It's awfully tempting to poke your head out of your tent or bedroom window, see clouds blotting out the stars and go back to sleep. Don't succumb. Sooner or later, you'll miss a great shot. Whenever I get tempted to hit the snooze button (which is almost every time I shoot) I remind myself of the first rule for chasing great light: the potential reward is always greatest when the odds against you are the longest.

All of us tend to be blind to phenomena that we don't understand or don't even know exist. The more deeply I understand the science of light in the sky, the more clearly I see the sky's awesome beauty. That sense of amazement and wonder was expressed well by John Muir, who wrote, "I used to envy the father of our race, dwelling as he did in the new-made plants and flowers of Eden. But I do so no longer. For I have discovered that I too live in creation's dawn. The morning stars still sing together and the earth, not yet half-made, grows more beautiful every day."

It is this sense of wonder that makes landscape photography so captivating. Wonder is crucial to the success of my work—and, I might add, one of the keys to my happiness. Naturalist Sigurd Olson said it well when he wrote, "When you lose the power of wonderment, you become old, no matter how old you are. If you have the power of wonderment, you are forever young. The whole world is pristine and new and exciting. That, I think, is the secret to any artistic endeavor—as long as you can be excited, as long as you can wonder about the magnificence of the world and the whole universe, you'll stay forever young."

◂ FIGURE 4-37 These beautiful clouds lit up more than 15 minutes after the almanac time of sunset and cast a mauve glow over Candlestick Tower and Soda Springs Basin, Canyonlands National Park, Utah

FIGURE 5-1 The Sangre de Cristo Mountains from Star Dune, Great Sand Dunes National Park, Colorado

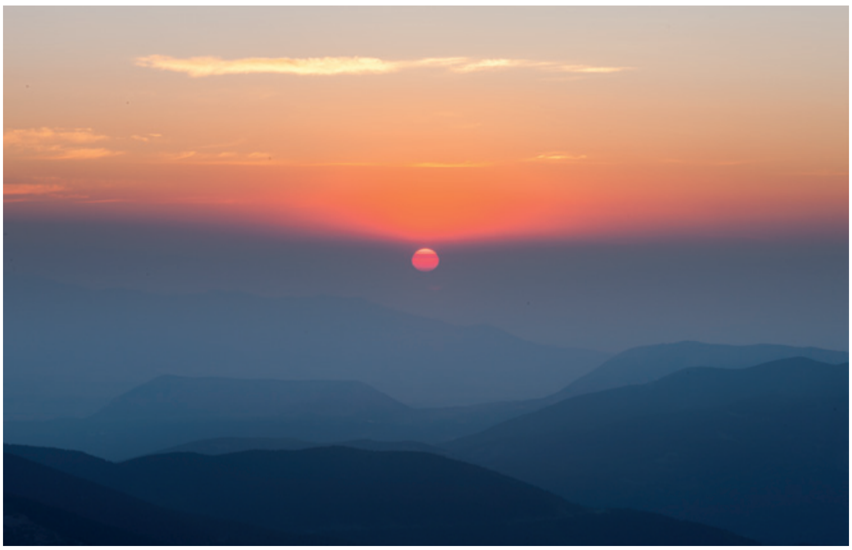
5

The Art and Science of Composing Compelling Images

Great landscape photography begins with a strong emotional reaction to the scene. Raw emotion by itself, however, is not sufficient to create a compelling photograph. With that emotion as the foundation, you now face the challenge of composing a photograph that will generate the same feelings in your viewer.

Don't let the word *composition* intimidate you. And don't be put off by the legions of dry, theoretical books that have been written on the subject. As Edward Weston once said, "To consult the rules of composition before making a picture is a little like consulting the laws of gravitation before going for a walk." The principles of composition are useful, and it can be helpful to read a book or two on the subject, but learning to use those principles is like learning to walk. Although learning to walk was hard and we all fell down a lot at the beginning, the activity comes naturally now that we have mastered it. In a similar way, experienced photographers simply *feel* that a composition is right—which means that for them composition is a highly developed but largely unconscious process. Skilled photographers don't run through a checklist of compositional principles before snapping the shutter.

The first step in creating a good composition is analytical. Decide what elements in the scene must be included to convey the emotion you're feeling. Include those, and only those. Exclude everything else. In other words, get close and keep it simple. Try to provide a center of interest, a focus of attention that the viewer's eye can linger on. You need to be clear in your own mind about why you are making the photograph. Then be sure that every element in the frame helps make that reason obvious to the viewer.



◂ FIGURE 5-2 Looking east from the summit of 14,042-foot Mt. Lindsey at sunrise, Sangre de Cristo Wilderness, Colorado

▲ FIGURE 5-3 Turks Head and the Green River at sunrise, White Rim area, Island in the Sky district, Canyonlands National Park, Utah

As I mentioned in chapter 1, we have the impression that our eyes take in an entire scene in a single glance, but that's not actually the way we examine our surroundings. The angle of view within which we see with the greatest sharpness and most accurate perception of color is actually quite narrow. We direct this narrow spotlight of sharp vision, called foveal vision, from object to object, fixating briefly on each one before moving on to the next. We are largely unaware of objects in between those that we have chosen to fixate on, which is one reason we so often fail to notice the beer can hiding under the clump of flowers—until it shows up in our photograph.

This quirk of our visual system has relevance when it comes to composing a photograph. Most beginners repeatedly make the mistake of including far too much irrelevant clutter around the main subject. I remember my excitement many years ago in Denali National Park when I came across a grizzly bear several hundred yards away that was busy digging up ground squirrels for lunch. I blazed away happily with a 300mm lens, confident I had some great shots. When I got the slides back from the lab, however, I saw that what I really had was a tiny grizzly dot in the middle of an otherwise empty frame. My attention was focused so strongly on the bear that I had failed to notice what was really within my frame—mostly nothing. Your visual system has a tremendous capacity for selective attention. Cameras have none. Be sure your main subject fills the frame.

You've probably heard the rule, "Don't center the main subject." While this is sometimes good advice, it requires qualification. When I judge photo contests at camera clubs, I often see photographs of a single flower set against an out-of-focus green background. In many cases the photographer has arbitrarily shoved the subject off-center to avoid breaking this compositional "rule," but there's no reason apparent to the viewer why the subject has been moved off center. A better solution with that type of subject is usually to compose so tightly that the flower fills the frame. It's centered, but it *has* to be centered. There's no other place for it go. Moving it off center would simply make it feel crowded against the edge of the frame.

Another common beginner's mistake, related to the mistake of including acres of trivia, is to allow some distracting element, like a branch or

twig, to jut unnoticed into the frame—unnoticed, that is, until you examine the image closely on your monitor. I once shot half a roll of photos of a spectacular group of towers in Rocky Mountain National Park at sunrise in winter. After picking up the processed film, I was startled to see that in frame after frame, one-third of the photo was black. I certainly hadn't seen anything black as I was looking through the viewfinder—or rather, I hadn't *noticed* anything black. I finally concluded that my black camera strap must have blown into the field of view of my ultra-wide fisheye lens as I was lying on my stomach in the snow in a vicious windstorm. I was concentrating so hard on the towers and the rising sun I had simply failed to notice what I was really taking a picture of. You must consciously train yourself to do "border patrol"—to run your eye around every edge of every frame, every time, to make sure nothing unwanted is intruding on your composition.

▲ FIGURE 5-4 Aspen grove on top of Stealey Mountain at sunset, near Owl Creek Pass, San Juan Mountains, Colorado

The same principle applies, more subtly, in the interior of the frame, in the spaces between the various elements of your photograph. Many years ago I was working in Colorado's Flattops Wilderness when I came across a spectacular field of columbines. Overall, the field must have been 100 feet wide and 30 feet high as it stretched up a gentle hillside. Closer examination,

however, showed that the columbines were by no means uniformly distributed across the field. Instead, they grew in small clumps, with two- and three-foot wide patches of green vegetation in between each clump. Composing an effective overall shot of the field proved to be devilishly difficult. No one clump was so large and rich that it could stand on its own as the center of attention, so I tried to find a composition that would include several good clumps in a pleasing arrangement. Each attempt, however, resulted in a dead spot somewhere in the composition—an area that lacked interest, where the eye refused to linger. As I was looking at the scene directly, rather than through the camera, my eyes readily skipped over all the uninteresting green foliage as they darted from one beautiful group of columbines to the next. The eye seems less willing to do that when looking at a photograph; areas that lack interest seem to jump out and shout, "boring!"

Remember that the end product of your efforts will be a flat, two-dimensional representation of the scene in front of you. You know instinctively as you look at the scene that the dead, ugly twig a few inches behind the gorgeous flower isn't growing directly out of the flower, but it will look that way in the photograph if you compose the shot so that the twig is directly behind the flower. A more familiar example is the telephone pole that appears to be growing out of your daughter's head in the photograph. While composing the shot, you saw clearly that the telephone pole was 20 feet behind your daughter. All photographs tend to flatten out space because they give you fewer depth clues than you had when you were standing there in person. Be sure to do a "background check" of the composition before you snap the shutter and make sure that the relationship between foreground and background elements is precisely the way you want it.

All this emphasis on framing tightly should not blind you to the fact that sometimes context is important. A very tall mountain will often look taller if you include some portion of the lesser peaks nearby, so the viewer has some basis for comparison and can see how tall the giant peak really is. Is that flower field really a strong enough subject to stand on its own? Or is the charm of the scene actually caused by the juxtaposition of delicate flowers with the power of the waves beating against the cliffs below? Perhaps both waves and flowers need to be included to make your statement clear.

The principle of including some standard for comparison can also help you compose shots of extraordinary optical phenomena—spectacular sunsets and rainbows, for example. If you entirely fill the frame with a glowing orange rock lit by an especially intense display of alpenglow, the viewer might well conclude that you'd simply stuck an orange filter over the lens or altered the color in Photoshop. Include the rich blue sky and bluish shadowed rock surrounding the orange glow, and the viewer can better appreciate just how unusual the alpenglow truly is.

▲ FIGURE 5-5 Dead Horse Point at sunrise, Dead Horse Point State Park, Utah. I placed the camera so the top edge of the Utah juniper wouldn't break the curving line of the bank of the Colorado River.

The Essentials of Graphic Design

Now you've decided what elements to include and what to exclude. How do you arrange those elements within the frame? How will you handle the "graphic" part of your photograph?

The answer begins with your original reason for making the photograph. What elements in the scene are most important in conveying your message? Make them large, bold, probably somewhere not too far from the center of the frame. Which elements, if any, are crucial to provide context, yet can play a supporting role? Render them smaller, closer to the edge of the frame, yet not crowded up against an edge or, even worse, jammed tightly into a corner.

▸ FIGURE 5-6 Cascade along the North Fork of the Crystal River, Maroon Bells-Snowmass Wilderness, Colorado

Emphasizing some elements and subordinating others is a matter of choosing the right camera position. Camera position determines *perspective*: the size relationship between near and far objects. Are nearby flowers, as measured on the print, three times as large as the distant peaks? Or are the flowers small colored dots at the foot of a gigantic mountain? These relationships—the perspective—are determined by where you put the camera, not the lens you choose. If you shoot a scene with a telephoto lens, then shoot the same scene from the same camera position with a wide-angle and crop the wide-angle shot down to include only those elements within the telephoto shot, you'll have the same picture, with the same size relationship between near and far elements.

To emphasize the foreground elements in the scene, move the camera closer to them. That may mean you need to switch to a wider-angle lens so you can continue to include the background. To reduce the importance of the foreground elements, move the camera away from them. That may require you to switch to a longer focal-length lens to avoid including extraneous elements in your shot.

◂ FIGURE 5-7 I used a 35mm lens to make this photograph of Green Mountain, near Boulder, Colorado

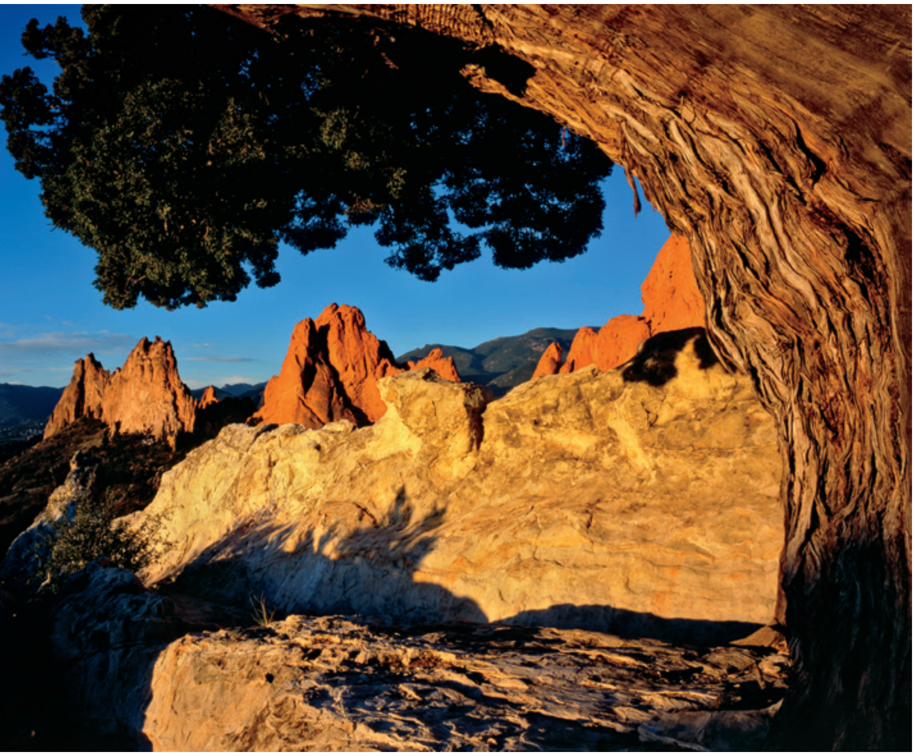
◂ FIGURE 5-8 This is the same image shown in figure 5-7, cropped to show the angle-of-view of a 70mm lens

◂ FIGURE 5-9 I shot this image with a 70mm lens from exactly the same camera position I used for the image in figure 5-7. There is no difference in perspective between this shot and the 35mm shot cropped to the same angle of view.

An old saw says that the $10 photographer sees a scene he likes and takes a picture. The $100 photographer sees the scene, steps three feet to the left, and takes the picture. The $1,000 photographer sees the scene, steps three feet to the left, steps one foot back to the right, and takes the picture. Selecting the right camera position is that critical. In fact, sometimes moving the camera just an inch or two can significantly improve the composition of a grand landscape if some elements within the frame are close to the lens. Precise compositions—those in which a small movement of the camera produces a significant change in the composition—are often pleasing because the photograph seems like a carefully considered record of a particular place rather than a generic image that could have been made anywhere within a hundred-yard radius.

Many of my students have a tendency to arrive at our shooting location and plant themselves in one place. They extend the legs of their tripod so they can position the camera conveniently at eye height and shoot every frame from that position. Sure, they zoom in and out and point the camera in different directions, looking for the best composition, but they don't compose with their feet. Before putting the camera on the tripod, look through it handheld and consider all the possibilities. Maybe the best shot is from knee level or waist level, or from three feet to the left or ten feet to the right.

▾ FIGURE 5-10 Gray Rock and South Gateway, Garden of the Gods, near Colorado Springs, Colorado. I placed the camera so the right-hand of the two towers would fit into the notch in the branches above.



Composing with your feet (or knees and elbows) is particularly important when shooting a field of wildflowers. Here the goal is to optimize the flower field's optical density. For every flower field, there is an optimum height of the camera above the ground. If you place your camera at ground level, more distant flowers line up behind the foreground ones, and the flower field looks very dense (that's good) but also very shallow, occupying only a small portion of the frame if you also include the distant peaks (not so good). On the other hand, if you place the camera at eye level, the flower field looks broad (that's good) but also sparse because the flowers themselves will look small

and you can see all the gaps in between the blossoms. The ideal placement of the camera is usually somewhere in between those two extremes. When you've found the right place, the field will appear lush, with a good density of flowers, yet expansive, so it fills a reasonable portion of the frame.

Photographers are often advised to "work the scene," meaning they should shoot a variety of compositions of the same subject. This is good advice, but it needs clarification. Landscape photographers should work the scene by looking at all the possibilities *before* the light hits. It's usually best to identify one ideal composition, dial it in to perfection, then wait for the light to peak rather than trying to shoot three different compositions during the fleeting moments of great light. Perfecting a composition takes time, particularly if you're setting up the tripod on uneven ground. I usually try to resist the temptation to change compositions at the last minute if the clouds behind me light up instead of the ones in my frame. All too often I find that the good light behind me is gone before I can dial in a satisfying new composition. To add insult to injury, the clouds in my original composition usually light up as I'm struggling to perfect the new shot, then fade as I frantically try to redo the original composition that I should have stuck with the entire time.

▲ FIGURE 5-11 Druid Arch reflected in a pothole, Elephant Canyon, Needles District, Canyonlands National Park, Utah

Balance and Depth

Books on composition are full of abstract discussions of the connotations of various geometric forms. For example, much has been written about the properties of lines. Vertical lines are said to be in balance; diagonal lines are falling or are about to fall. Jagged lines are tense, nervous, full of energy; horizontal lines are at rest. Curved lines are graceful and soothing. In my opinion, these concepts, while worthwhile to keep in mind, are often more useful to the graphic designer working with simple lines and shapes than

they are to a nature photographer working with natural forms. The key elements of graphic design for the landscape photographer are balance and a sense of depth.

Let's start with balance. During the Renaissance and earlier, European artists gave their paintings balance by using symmetrical compositions. If the painter put three supporting figures to the right of the main figure, then he would put three figures to the left as well. Similarly, architecture was also often painted symmetrically, so that the left half of the painting would be a mirror image of the right. While effective in achieving balance, these paintings were also stiff and static.

Since the Renaissance (and much earlier in the traditions of oriental art), most painters have favored asymmetrical compositions, in which balance, while still desirable, is not a given. Instead, balance must be carefully constructed, with each element placed to fit harmoniously with the others. It's helpful here to remember the principle of the lever and fulcrum. A large, heavy object near the center of the frame can balance a smaller, lighter object at a greater distance from the center and on the opposite side of the frame, just like the big kid sits closer to the center of the teeter-totter than the small kid on the opposite side. As you arrange the elements of your picture within the frame, you also need to be aware of their relationship to the frame itself. If an important element with a distinct edge is placed too close to the frame, it will feel crowded. If placed too far from the frame, the viewer will see the extra space as wasted or useless. Take a look at *Lone Eagle Peak Reflected in Mirror Lake*. The large, heavy mass of Lone Eagle Peak balances with the smaller peak to the right. The dark masses of trees are similarly balanced with each other and with the peaks and their reflections. To achieve this, I walked back and forth along the edge of the lake until all the major subject elements fit harmoniously within the frame.

Sometimes, of course, it's neither possible nor desirable to include all of the subject. Let's say you're shooting an expansive field of flowers. Excluding the borders of the flower field, so that the flowers entirely fill the frame (or a large portion of it) makes the viewer think the flower field continues forever. On the other hand, cutting a small clump of flowers in two with the edge of the frame looks like a mistake. In that situation, you'll generally want to either include the entire clump cleanly, like you planned it that way, or exclude it completely.

Some photographers use the Rule of Thirds as a guide when composing images. Imagine dividing the picture space into nine equal-sized areas by

◂ FIGURE 5-12 *Lone Eagle Peak Reflected in Mirror Lake,* Indian Peaks Wilderness, Colorado

drawing two equally spaced vertical and two equally spaced horizontal lines across the frame. The intersections of those lines are supposed to be good places for the main subject.

Can the Rule of Thirds actually help landscape photographers compose better-balanced photos? Frankly, I'm skeptical. There's little scientific evidence supporting the idea that placing the main subject at any of those four "power points" leads to consistently better compositions. Too often, constructing a photo so it adheres to this rule leads to compositions that feel forced rather than organic.

Although the Rule of Thirds is too rigid and arbitrary for my taste, the underlying principle is sound: completely symmetrical landscape compositions are rarely as interesting as asymmetric ones. This principle is particularly helpful when deciding where to place the horizon, especially when the horizon is straight. I rarely place the horizon dead center, halfway between the top and bottom edges of the frame. Usually I choose to favor either the sky or land. In the absence of other considerations, a one-third/two-thirds split often works well. Reflections are one exception to the no-symmetry rule. Placing the shoreline halfway between the top and bottom of the frame can sometimes emphasize the symmetry of the reflection in a pleasing way.

Let's move on to the second critical aspect of graphic design for the landscape photographer: depth. The sense of realism in a nature photograph is strongly enhanced if the image has a sense of depth. Obviously, realism need not be your goal in every shot. Nature abstracts can be just as pleasing to the eye and satisfying to make (though probably not as salable) as grand landscapes. If your goal, however, is to make images that give the viewer the sensation that they can walk right into the frame, then you need to consider ways to enhance the illusion of depth. As Harvard researcher Margaret Livingstone wrote in her book, *Vision and Art: The Biology of Seeing*, "Artists must look at a three-dimensional scene with their two-dimensional retinas and then generate a two-dimensional painting that appears three-dimensional to viewers who look at it with their two-dimensional retinas."

The sense of depth in a photograph is enhanced by several mechanisms: converging lines, size relationships, overlapping elements, and aerial perspective. Let's take these elements one at a time and explore each more fully.

The sense of depth created by converging lines is shown clearly by the way railroad tracks seem to come closer together as they recede into the distance. The lines formed by the banks of a stream or a narrow arm of a lake can have the same effect. In the absence of water, you need to attune your eyes to more subtle, implied lines in your composition. The implied lines formed by the bases and tops of trees along the side of a meadow can form converging lines that lead your eye into the frame as you look down the

length of the meadow toward distant peaks. The eye subconsciously tends to identify a series of dots as a line, a principle the Gestalt psychologists of the early 20th century called *closure*. A series of stones can work as an implied line. Converging lines most strongly create a sense of depth if they come in pairs, like railroad tracks, but a single line leading diagonally across the frame can serve the same function if other clues in the picture also work to enhance the sense of depth.

Closer objects look bigger to us; distant objects look smaller. You can use this principle to create a sense of depth, particularly when you have a group

▲ FIGURE 5-13 Sunrise over Wetterhorn Peak from the summit of Uncompahgre Peak, Uncompahgre Wilderness, Uncompahgre National Forest, Colorado

▲ FIGURE 5-14 By using a wide-angle lens and placing the camera close to the foreground flowers, I created a size gradient that enhanced the feeling of depth in this image of lupine, Wolcott Mountain, Mears Peak, and Peak 13,134 at sunset, Mt. Sneffels Wilderness, Colorado.

of objects that the viewer assumes are all the same size, such as flowers of a particular species. Using a wide-angle lens, move in close to the nearest flowers. That will render them large in the frame, which will make the other flowers diminish in size as they recede into the distance, thus enhancing the illusion of depth.

If same-sized objects are regularly spaced, such as the furrows in a plowed field, the technique of moving close to the nearest one has another effect. More distant objects not only look smaller, but also look closer together. Some artists call this a texture gradient. It also enhances the feeling of depth.

The overlapping of objects is another important depth clue. We naturally assume that if the outline of an object blocks our view of another object, the

second object is behind the first. The artful overlapping of some of the main elements in the photograph can help enhance the photo's feeling of depth. On the other hand, if you place two objects that are at different distances so their edges exactly meet, but do not overlap, you lose the perception of depth. Unless you're interested in creating optical illusions (a cow that appears to be standing on a man's hand, for example), you should usually avoid such compositions.

I touched upon the final depth clue—aerial perspective—in the chapter on light. The blue light scattered from the atmosphere between you and a distant

▸ FIGURE 5-15 This image of Longs Peak and Glacier Gorge from Bear Lake in autumn, Rocky Mountain National Park, Colorado, clearly shows the way aerial perspective enhances the sense of depth

▲ FIGURE 5-16 The converging lines formed by the banks of this stream enhance the feeling of depth in this image of Mt. Neva and Parry's primroses, Indian Peaks Wilderness, Colorado

object makes the object appear bluish. The same object, if seen from a closer distance, would lack that blue cast. As a result of this phenomenon, warm colors in general seem to come forward; cooler tones tend to recede. Haze also softens the details and edges of distant objects. The ability of slight haze to enhance the feeling of depth is one reason you should think carefully before using a polarizer, which cuts through haze when you are looking at a 90-degree angle to the sun. If you render everything in your photograph, from near to far, in razor-sharp detail, you can reduce the feeling of depth, which may be undesirable.

Focus Stacking

In the film era, your choice of camera position was sometimes limited by your inability to get full depth of field with the lens required. For example, your ideal composition for a grand landscape of flowers and mountains might require placing the camera two feet from your foreground flowers and using a 35mm lens. A wider lens would include extraneous clutter; a longer lens would cut off the tops of the mountains. Unfortunately, the maximum depth of field of a 35mm lens on a full-frame camera, even at f/22, only extends from about four and a half feet to infinity—not enough, in this example, to keep everything sharp with your ideal composition. Fortunately, digital cameras and appropriate software provide a solution: focus stacking.

The technique is simple, but does require either the full version of Photoshop or specialized focus-stacking software. Set up your shot with the camera on a tripod, focus on the closest part of your subject, and make the

first frame. Focus on something slightly farther away from the camera, and shoot a second frame. Continue shooting additional frames until you've made one that is focused on the most distant part of your subject.

The next step is getting all the images into Photoshop as layers in a single document. If you have both Lightroom and Photoshop, the job is easy. Select all the images in Lightroom and choose Photo>Edit In>Open as Layers in Photoshop. Once the images have loaded, select the top layer, then Shift-click on the bottom layer to select all the layers. Choose Edit>AutoAlign Layers. In the next dialog box, I usually choose Auto as the type of projection, but I have found that sometimes Cylindrical or Perspective produce less distortion of the original rectangular shape. Under Lens Correction, check Vignette Removal and Geometric Distortion. Click OK. Next, choose Edit>AutoBlend Layers. Under Blend Method in the next dialog, choose Stack Images, and be sure Seamless Tones and Colors is checked.

If you don't have Lightroom, start from Bridge, which ships with Photoshop. Choose all the images in your focus stack, then choose Tools>Photoshop>Load Files into Photoshop Layers, and proceed as described before.

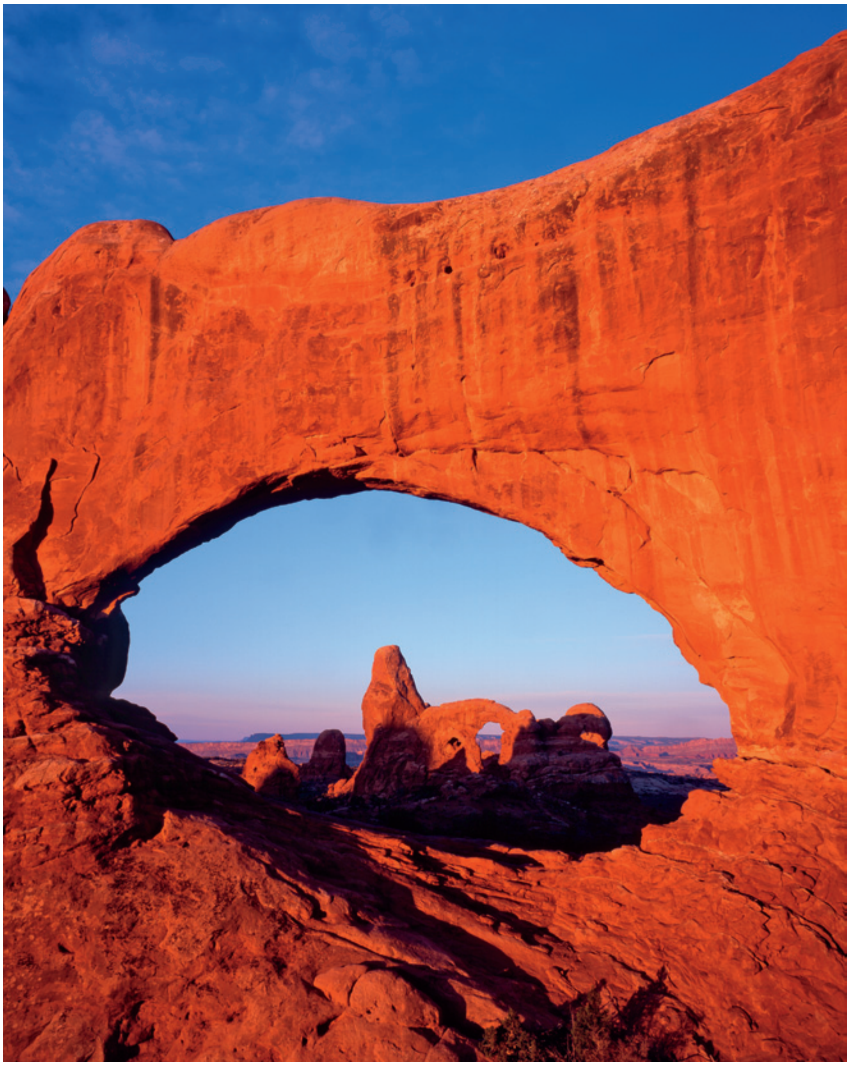
Focus stacking works best with wide-angles and when doing macro work. Obviously, no part of the subject can move in between frames. Trying to focus stack flowers on a windy day is a sure route to hair loss. Be sure to compose generously by including a bit more of the subject than you want to appear in the final image. Even if your technique is perfect, it's common to find minor blending and merging errors along the edges of the frame, which must be cropped away. Check the interior of the image carefully as well. In some situations you'll find narrow, out-of-focus "halos" around foreground objects, particularly when shooting with a telephoto lens. These halos can be corrected in Photoshop by selecting the foreground object, inverting the selection, and cloning portions of the sharp background image over the blurry halo. The task can be laborious, and the details are beyond the scope of this book.

▾ FIGURE 5-17 Focus stacking enabled me to get full depth of field in this image of Pursh's wallflower and alpine parsley near the summit of Mt. Shavano, San Isabel National Forest, Colorado

Color

A lot has been written about the meaning of colors. Black is sometimes associated with death and mourning. Green is the color of spring; yet we also say "he's green with envy." Red is often used to imply violence and war, but red is also associated with passion and love. Which is it? The truth is that the meaning you associate with a color is strongly determined by context and by the culture in which you grew up. In some countries, for example, white, not black, is considered the color of mourning. There's no need to memorize a list of color attributes and cling to it as a rigid standard.

▸ FIGURE 5-18 The near-complementary colors in this photo of Turret Arch through North Window, Windows area, Arches National Park, Utah, help make the image pop



Color does have certain universal attributes that photographers should know. Let's start with the idea of primary and complementary colors. The topic is confusing because the colors considered primary and complementary differ depending on whether you're talking about mixing light or mixing paint. As photographers, we're concerned with light, so I'll limit my explanation to that type of color mixing.

First, some background. Our eyes have two types of light-sensitive cells: rods and cones. Rods are responsible for vision in low light. They're much more sensitive than cones, but can't detect differences in color. Cones function in brighter light and are responsible for color vision. They come in three types, each sensitive to a different region of the visible spectrum. For ease of discussion, let's call them red-sensitive, green-sensitive, and blue-sensitive cones.

Do those colors sound familiar? They are, of course, the colors we use to create the colors in our digital images. When we are discussing colors of light, red, green, and blue are considered *primary colors;* different mixtures of these colors of light can create all visible hues.

The first stage of color vision is simple: when red light hits red-sensitive cones, they fire, and so on for the other colors. The next stage is more complicated. Our visual system is wired so that it compares activity in red-sensitive cones with the *sum* of activity in the green and blue cones. Green and blue make cyan, so you can think of this as placing the color on a red-cyan axis. Similarly, our visual system also compares activity in the blue-sensitive cones with the *sum* of activity in the red- and green-sensitive cones. Red and green make yellow, so you can think of this as placing the color on a blue-yellow axis. All visible colors can be specified by their position in a color space defined by these two axes. (Photoshop mavens will recognize that this is how color is defined in LAB mode, which uses three channels: luminosity [the L channel], red-cyan [the A channel], and blue-yellow [the B channel].)

If activity in the red cones is balanced by activity in the green and blue cones combined, we see an achromatic color: white, or at least neutral. Red and cyan are *complementary* colors; when these colors of light are mixed together they make white. Similarly, blue and yellow are complementary, as are green and magenta—or any other pair of colors of light that make white when mixed together. Cyan, magenta, yellow—do those colors sound familiar? These (plus black) are the colors of ink that we use in our inkjet printers.

Here's where it gets really intriguing. Colors that neutralize each other when mixed will strongly enhance each other when they are adjacent. The explanation is too complicated to detail here, but this is a measurable physiological effect. Red-sensitive double-opponent cells in our visual system will fire more strongly if cyan light strikes the adjacent region of the visual

▲ FIGURE 5-19 The already intense color in these aspen trees is accentuated by placing them against a dark background in this image of storm light over the Cimarrons, Uncompahgre National Forest, Colorado

field than if the surrounding region is hit by white light. This is also true for other pairs of complementary colors. To make your images pop, look for complementary colors, such as yellow aspen leaves in the fall set against a brilliant blue sky. Magenta Indian paintbrush set against rich green foliage is an equally vibrant combination. As an aside, colors also look more saturated when set against a dark background.

Such bold, eye-catching colors aren't necessarily what you want in every shot. You may find that more subtle color combinations look much better in a photograph that you intend to hang on your wall for years to come. As I look through the images that became my best-selling prints, I can find examples that are studies in cool blues, greens, and purples; others that exhibit strongly complementary colors (both floral and fall-color shots); and even one that is a study in vibrant orange and black. Clearly there is a large degree of personal taste in what color combinations are most appealing in a landscape image. According to Mark Fairchild, a professor of imaging science at Rochester Institute of Technology, "Color preferences are difficult to quantify and specify, but in general people prefer color reproductions that are accurate in hue, slightly more saturated than the original scene, and higher in contrast (the rate of change from dark to light)."

Hue is not the only aspect of color that is important. The brightness of a color also affects our perception of it. For example, our eyes often go first to the lightest tones in a photograph. Painters use this principle when they make the face of their subject a light tone set against a darker background. Using a light tone helps direct the viewer's eye to the most important part of the picture. Although photographers can't manipulate color and tones quite as directly as painters can, they can ensure that their main subject is not excessively dark. Often this principle is most helpful when considered in a negative sense. A bright white object near the edge of the frame, such as a white granite boulder or, even worse, a piece of white trash, can be very distracting. Bald white skies can be equally distasteful. Avoid them when possible, and keep them to an absolute minimum when it's necessary to include them.

In the end, learning to create dynamic, balanced compositions is a matter of study, practice, more study, and more practice. Before writing this chapter, I spent more than 20 years practicing the art of composition. I also read half a dozen books and numerous articles in scientific journals looking for some kind of objective foundation. What I learned is that composition is one aspect of photography where science can only take you so far. In the 19th century, the Classic Revival painters believed that good composition boiled down to a group of formulas. Ultimately, their work came to be seen as stiff, formal, and lacking in imagination. I can't enumerate a set of rules for you,

which is one reason why composition is so hard to teach. Getting feedback from more experienced eyes can be helpful. We all have difficulty evaluating our own work, particularly at the beginning of our careers. Look with great care at the work of photographers you admire and consider every aspect of their compositions. Once in the field, slow down. One of the unheralded virtues of using a tripod is that it allows you the luxury of considering your composition at length. Don't be satisfied with the first composition that feels vaguely right. Continue to refine it by making small changes to camera position until nothing more needs to be added, nothing more can be stripped away, and every element in the scene is positioned in perfect harmony with every other element.

◂ FIGURE 5-20 This image of columbines along the trail to Arapaho Pass, Indian Peaks Wilderness, Colorado, is my all-time best seller as a print

FIGURE 6-1 Aspens below Mt. Jackson, the east fork of the Cimarron River and Uncompahgre Peak, San Juan Mountains, Colorado

6

The Perfect Exposure

Today's digital cameras are basically computers with lenses attached. After spending all that money on the latest gee-whiz electronic gadget, you may be thinking, "Why do I need to learn all this technical stuff? Why not let the camera pick the right aperture, shutter speed, ISO, and white balance (whatever that is)? I'll worry about the fun, creative stuff—choice of subject, composition, and timing—and let the camera handle the rest."

Sometimes "auto-everything" will indeed give you exactly what you want. In many situations, however, auto-everything will fail miserably. If you really want to master the art of photography, you should start by mastering the craft, beginning with learning to determine correct exposure.

In this chapter, I'll first discuss how light meters work. Next, I'll teach you to recognize "exposure danger zones"—situations where your camera's meter cannot be trusted. Some of these are obvious; you can recognize them without even taking your camera out of its bag. Others require shooting a test frame and examining the histogram, a crucial tool that I'll discuss in detail. I'll also describe the four basic exposure strategies as well as the Universal Exposure Strategy, which can be the best approach of all in certain circumstances. After finishing this chapter and the next, you should be able to photograph any landscape subject in any light, and be confident that the final print will have the detail and tonality you want throughout the image.

How Light Meters Work

The function of the light meter inside your camera may seem obvious: it measures the light in a scene to determine the right exposure. But what is the right exposure from a light meter's point of view? Your meter assumes that the world, on average, is a midtone. In black-and-white terms, it assumes that the world is a middle gray—halfway between black and white. In technical terms, meters assume that the scene, on average, reflects 18 percent of the light falling on it, which human vision interprets as a middle tone. Reflected-light meters, as they're called, always recommend an exposure that will render the main subject as a middle tone. So if you fill the frame with an evenly illuminated middle-gray rock, being sure that there is nothing in the frame but rock, and use the exposure recommended by the meter, you get a middle-gray rock—exactly what you want.

▲ FIGURE 6-2 Roseroot, alpine avens, and Parry's clover along the Blue Lakes Trail, Mount Sneffels Wilderness, San Juan Mountains, Colorado. Your camera's meter is dead-on accurate for images like this, which have a midtone subject and soft lighting.

If, however, you fill the frame with a white snowfield, a white waterfall, or a white sand beach, and use the exposure recommended by the meter, you get a gray snowfield or waterfall or beach—not what you want. Fresh snow can reflect as much as 90 percent of the light falling on it, but your meter assumes that the subject reflects only 18 percent. You have to increase the exposure by a stop or two to compensate, so that your white subject stays white, but maintains printable detail. You can increase the exposure by using a longer shutter speed or bigger aperture (if you're in manual exposure mode) or by setting exposure compensation to the plus side (if you're in one of the automatic exposure modes).

Similarly, if you fill the frame with a dark subject, such as dark rock or a black bear, and use the exposure recommended by the meter, you will get a gray rock or gray bear. You have to decrease the exposure by a stop or two to compensate, so that your dark subject stays dark. You can decrease the exposure by using a shorter shutter speed or smaller aperture (if you're in manual exposure mode) or by setting exposure compensation to the minus side (if you're in one of the automatic exposure modes).

Now you know how to compensate for subjects that aren't midtone. Is that all you need to know to achieve correct exposure in every case? Unfortunately, no. There are many other situations that scream, "exposure danger zone ahead!"

Exposure Danger Zones

Exposure danger zones come in two basic categories: situations where the scene is not midtone, and situations where your sensor can't record the wide range of brightness levels in the scene. In the examples that follow I've used a variety of ways to hold detail everywhere in the frame. You'll learn all of these techniques in this and the next chapter.

1. Any scene that is mostly white: snow, waterfalls, white sand. You should increase exposure to compensate (figures 6-3 and 6-4).

▲ FIGURE 6-3 Hallett Peak from Dream Lake after a 44-inch snowfall, Rocky Mountain National Park, Colorado

▲ FIGURE 6-4 Waterfall near the Grottos, Roaring Fork River, White River National Forest, Colorado

◂ FIGURE 6-5 Bison near Lookout Mountain, Colorado

2. Any scene that is predominately dark: very dark rock, dark-furred animals. You should decrease exposure to compensate (figure 6-5).

3. Any scene where you have an important foreground in shade and a background in full sun. If the foreground is shaded only by thin clouds, the range of light intensities may still be within the range of your sensor if the scene is perfectly exposed. If the foreground is shaded by thick clouds or something solid, such as a mountain or canyon wall, the range

▲ FIGURE 6-6 Lupines in Silver Creek Basin and Treasure and Treasury Mountains, Maroon Bells-Snowmass Wilderness, Colorado

▲ FIGURE 6-7 January sunset at Delicate Arch, Arches National Park, Utah

▲ FIGURE 6-8 Ski mountaineers approaching Mt. Sanford, Wrangell-St. Elias National Park, Alaska. Notice how the shadowed faces have gone completely black.

may be beyond the ability of your sensor to hold good detail everywhere in a single capture (figure 6-6).

4. Any backlit scene, meaning a scene where you are looking toward the sun or other light source (even if it is out of the frame). The sun in a clear sky is way too bright to expose with any detail, but even the sky around the sun is likely to be too bright to hold detail, and you may have difficulty achieving proper exposure in both the sky and the foreground shadows (figure 6-7).

5. Any scene in which only half the landscape is covered in snow, even if the entire scene is in full sun. A classic example is a green, flower-filled meadow with snowcapped peaks in the background (figure 6-8).

6. Any scene shot on a cloudy day when you have sky in the frame. The lighting on the land is very even, which means your sensor can easily record detail everywhere in that part of the image. However, the sky is always wickedly bright and can easily blow out to a very distracting pure white (figure 6-9).

7. Any scene with a pond or lake where you need a wide-angle lens to include both the subject and its reflection. The amount of light reflected from water is dramatically dependent on the angle of incidence of the light. The angle of incidence is the angle between the path of the incoming light and a line *perpendicular* to the surface of the water. Yes, I know that's counterintuitive, but that's the way scientists define it. Light with an angle of incidence of zero plunges straight down into the water; light with an angle of incidence of 90 degrees is traveling parallel to the water's surface. Light that strikes the water at a high angle of incidence (meaning it just barely grazes the surface) is nearly all reflected. The difference in exposure between the subject and its reflection might be only 1/2 stop—easily within the range of your sensor to capture good detail everywhere. If a 50mm or longer lens (on a full-frame sensor) is wide enough to include both the subject and its reflection, you're probably safe. If the angle of incidence is low (meaning the light is plunging steeply down into the water), much of the light is transmitted into the water and the difference in exposure between the subject and its reflection can be four or even five stops. That's too big a difference for your sensor to straddle comfortably. If you need a 24mm or wider lens to encompass both the subject and its reflection, you're in an exposure danger zone (figure 6-10).

▲ FIGURE 6-9 Columbines in American Basin, Handies Peak Wilderness Study Area, Colorado

◄ FIGURE 6-10 Notchtop Mountain reflected in Lake Helene, Rocky Mountain National Park, Colorado, shot on 4×5 film with the equivalent of a 20mm lens

▲ FIGURE 6-11 The Milky Way over Longs Peak from Trail Ridge Road, Rocky Mountain National Park, Colorado

8. Any night scene, particularly if your foreground includes evergreen trees and the sky includes the glow of a nearby city (figure 6-11). I'll discuss night photography in depth in chapter 9.

Once you've recognized an exposure danger zone, how do you deal with it? You can, of course, just "spray and pray"—shoot a whole bunch of frames of the scene at different exposures and hope for the best. However, that's hardly an ideal solution. First, things may be happening so fast that you can't bracket exposures. What if you're shooting sports, or wildlife, or your daughter's first step? What if you're shooting flowers in a grand landscape and the wind only stops once during the fleeting seconds of perfect light? In some situations, your first capture is your only capture, and the exposure had better be right.

A mindless strategy of always bracketing your exposures can also fail when the dynamic range of the scene exceeds the dynamic range of your sensor. In that situation, no single capture will contain all the detail you want in both the highlights and shadows. While bracketing is sometimes essential, it should not be the only tool in your exposure-strategy toolbox.

Histograms

Your best guide to exposure in the field is your histogram, not the appearance of the image on the LCD. In its simplest form, a histogram is a black-and-white graph of the tones in your image. The horizontal axis is brightness. Although the scale is not marked on the histogram, it runs from zero (black) on the left to 255 (white) on the right. For the moment, think of the vertical axis as the number of pixels at each brightness level. I'll provide a more rigorous definition later.

Take a look at the examples in figures 6-12 through 6-17, which are from Photoshop CC with RGB selected as the channel. We'll start here because these monochrome histograms are similar to the composite (RGB) histograms you'll see on the back of your camera. I shot these photos under cloudy skies, meaning the light was low-contrast. Normally, that makes exposure easy. Notice, however, that the combination of a near-white subject (the aspen trunks) and the dark, shadowed areas visible between the trunks means that a correctly exposed frame uses the full dynamic range of the sensor and the histogram stretches from near-white to near-black.

▲ FIGURE 6-13 This is the histogram for the correctly exposed image in figure 6-12. There is no "clipping" in the highlights, which means that the mountain of data is not cut off by the right side of the graph. There is only a very small amount of clipping in the shadows. Small amounts of pure black in a landscape image are actually often an asset.

▲ FIGURE 6-12 This image is correctly exposed, with no blank white highlights and no large areas of pure black.

▲ FIGURE 6-15 This is the histogram for the underexposed image in figure 6-14. The mountain of data is cut off on the left side, meaning that a large number of pixels are pure black, with no detail.

▲ FIGURE 6-14 This image is underexposed. The white aspen trunks are dull gray instead of near-white, and large areas of the shadows have turned black.

▲ FIGURE 6-17 This is the histogram for the slightly overexposed image in figure 6-16. Notice how the mountain of data is cut off by the right side of the graph, meaning that a significant number of pixels are pure white, with no detail.

▲ FIGURE 6-16 At first glance, the exposure for this image looks good, but close examination shows it is slightly overexposed. Some areas of the trunks are blown out to pure white, as can be seen on the histogram in figure 6-17. This example shows why it's important not to use the image shown on your camera's LCD panel to judge exposure. It's better to trust the histogram.

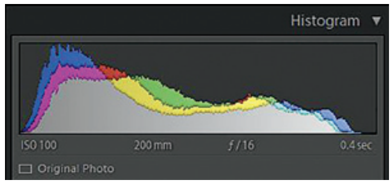
I mentioned previously that the vertical axis on Photoshop's RGB histogram does not, strictly speaking, represent the number of pixels at each brightness level. In other words, the software (and your camera) doesn't simply take the average of the red, green, and blue values for a particular pixel and plot that on the histogram. Instead, the histogram plots "counts": one count is recorded at each level for every pixel where the red, green, or blue value is equal to that level. In other words, a pixel with red, green, and blue values of 255, 240, and 225 provides one count at the 255 level, as well as one count each at the 240 and 225 levels.

Engineers designed the histogram this way so that if any channel reaches 255 for a given pixel, you'll see it on the histogram as a count at 255. If the software simply averaged the red, green, and blue values for each pixel, pixels that were clipped in one channel wouldn't appear at the far right side of the graph even though they might be dangerously close to clipping overall.

It's important to note that camera histograms are, by design, rather conservative. I've found that if I really have to, I can overexpose by one stop beyond the point where the histogram says the image is almost clipped, and achieve barely printable detail in Lightroom as long as I'm shooting in RAW format (the only format I use for capture). Remember, a portion of your image placed that far above a midtone density won't hold good color and detail; it will be near-white, with barely printable detail. That degree of

overexposure is only appropriate for parts of your subject that you want to render near-white, such as brilliant white cumulus clouds, and only if you absolutely have to capture the broadest possible range of tones. You should test your camera to see how conservative your histogram is before relying on this technique.

Now let's take a slight detour and look at the more complex, multicolor histograms you'll find in Lightroom and Adobe Camera Raw. Although you may not see this type of histogram on your camera, it's important to understand what these histograms represent as you optimize your images in your favorite photo-editing program.



▲ FIGURE 6-18 This is the histogram from Lightroom 5 for the correctly exposed image in figure 6-12. The histogram in Adobe Camera Raw (the RAW processing engine that ships with Photoshop) is very similar.

In these histograms, the three color channels (red, green, and blue) are superimposed on one another. To understand this style of histogram, consider first the appearance of a histogram for only one channel. For instance, the red histogram plots the number of pixels with each red value. If there are 50 pixels with a red value of zero, it plots a count of 50 at the zero position at the far left side of the graph. If there are 65 pixels with a red value of 255, it plots a count of 65 at the 255 position on the far right side of the graph, and so on. The other two histograms, for blue and green, are plotted the same way. Lightroom and Camera Raw then stack all three histograms on top of one another. Areas where all three channels overlap are shown in gray. Areas where two of the three histograms overlap are shown in the color the two channels would make if mixed together. Areas where the blue and green histograms overlap are shown in cyan; the red-green overlapping area is shown in yellow; the red-blue overlapping area is shown in magenta. Areas where only one channel is present are shown in that channel's color.

Many DSLRs today can display not only a monochrome histogram, but also the three individual color channels, usually as separate histograms rather than the combined view discussed previously.

You should care about the brightness of the individual channels because clipping in even one channel is a warning sign that you may be on the verge of clipping the highlights or shadows overall. No digital magic can recover good color and detail from areas of an image that are pure white (areas where all the pixels have red, green, and blue values of 255, 255, 255), or pure black (areas where all the pixels have red, green, and blue values of 0, 0, 0). In my experience, however, minor clipping in just one channel as shown in the camera's histogram will not degrade the final image.

The Four Basic Exposure Strategies

Your knowledge of histograms will help you understand exposure strategies. In my view, there are four basic exposure strategies for landscape photography: PhD; Limiting Factor; the Rembrandt Solution; and HDR. Each strategy

has its niche in terms of the degree of contrast and type of subject matter with which it is most effective. The first two are relatively simple, so I'll discuss them fully here. The last two exposure strategies are more complicated, so I'll introduce them here, and then complete my discussion of them in the next chapter.

The PhD Strategy

No, you don't need a doctorate; PhD stands for Push Here, Dummy. In PhD situations, your camera's meter will give you a perfect exposure time after time; no thought required. Two conditions must be met: the lighting must be low-contrast, and the subject must be close to midtone throughout the frame. If *both* conditions are met, your in-camera meter is reliable. For example, if you're shooting closeups of flowers set amid green foliage on an overcast day, you can trust your meter and concentrate exclusively on creating the perfect composition of the best specimens. The overcast day means the light on your subject is very even, with no bright highlights or dark shadows, and the green foliage is very close to midtone.

The even lighting of an overcast day works very well for closeups, but it's usually deadly when shooting grand landscapes. Often the resulting photographs lack depth and dimension, which is why the lighting is said to be "flat." High-contrast lighting is usually more interesting for grand landscapes, but it also requires more thoughtful decisions about exposure.

▲ FIGURE 6-19 I used the PhD strategy to make this image of columbines and heartleaf arnica near No Name Creek, Weminuche Wilderness, Colorado

The Limiting Factor Exposure Strategy

There are many high-contrast situations where you need to get all the detail possible in a single capture. These situations include any subject that moves: wildlife, people, waterfalls, and delicate flowers and colorful aspen leaves trembling in the wind. The Limiting Factor Exposure Strategy will produce the single best frame you can achieve in such situations. The limiting factor

is the highlights: don't blow them out! You then let the shadows fall where they may and compose knowing that deep shadows will be very dark or black.

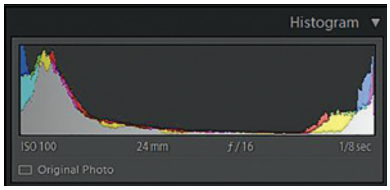
The easiest way to implement this strategy is to take your best guess at the correct exposure and shoot a test frame. Check the histogram. If the highlights are clipped, estimate how much darker your exposure needs to be to bring the highlights within range, and try again. Repeat until you have an exposure that is almost (but not quite) clipped. If the highlights fall well below clipping, estimate how much you need to open up the exposure and try again. Repeat until you have an exposure that is just shy of clipping the highlights. By placing the highlights as high as possible in the tonal scale, without blowing them out, you have also given yourself the best shadow detail possible in a single capture.

If you have a DSLR that offers Live View, you may also have a Live View histogram with exposure simulation. Check your manual: on some cameras, even high-end ones, this is a feature that must be turned on in the menus. If you do have a Live View histogram, setting the lightest exposure that still preserves highlight detail is simple: the histogram updates as you change the exposure compensation (if you're in one of the automatic exposure modes) or the shutter speed or aperture (if you're in manual exposure mode). (If you use manual exposure mode, remember that you'll want to adjust only shutter speed to preserve the depth of field achieved by setting a small aperture.) Simply engage Live View, cycle through the display modes until

▲ FIGURE 6-20 I used the Limiting Factor exposure strategy to make this image of aspen trees above Bear Lake in late September, Rocky Mountain National Park, Colorado

▲ FIGURE 6-21 The histogram for the image in figure 6-20

▲ FIGURE 6-22 The dynamic range of any scene with the sun in the frame is well beyond the ability of your sensor to hold pleasing detail everywhere



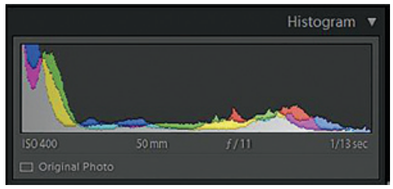
▲ FIGURE 6-23 This is the Lightroom 5 histogram of the image in figure 6-22. Both the highlights and shadows are severely clipped. Note also that there are virtually no midtones. I call this the Devil's histogram because it has two horns. Images like this are bound to give you problems.

the histogram is displayed, then adjust the exposure until the histogram shows that the highlights are almost (but not quite) clipped.

The Rembrandt Solution

Sooner or later, as the contrast in the scene increases still further, you'll encounter the *Devil's histogram*—a histogram with two horns representing large areas of near-black on the left and near-white on the right, with very little data in the middle of the scale, as shown in figure 6-23. This histogram is a warning that the scene contrast may exceed the range your sensor can straddle comfortably. If your subject includes only a white waterfall and black water-washed rocks, a histogram with pronounced spikes at each end may be acceptable if the highlights and shadows aren't clipped, but if your subject includes shadowed wildflowers and brilliant white cumulus clouds, watch out! Wildflowers, or more precisely the green foliage around them, must be rendered as a midtone to look

▲ FIGURE 6-24 Sometimes it's not so obvious that a scene is beyond the sensor's ability to capture shadows and highlights gracefully. My eyes saw excellent detail in both the shadowed evergreens and the colorful clouds, but my sensor couldn't comfortably straddle the six-stop range, as shown in the histogram in figure 6-25.



▲ FIGURE 6-25 Lightroom 5 histogram for the image in figure 6-24

good in a print. The Devil's histogram is showing you that a single exposure cannot simultaneously capture good highlight detail and render the green foliage as a midtone. The Limiting Factor exposure strategy is inadequate in such situations. It's time to consider the Rembrandt Solution.

Four hundred years ago, painters like Rembrandt tackled high-contrast scenes using a technique called countershading to create the illusion of greater dynamic range in their paintings than actually existed. Today you can achieve the same result with the use of graduated neutral-density filters. You can also use Photoshop to create the same effect with much greater flexibility and precision than is possible with physical filters. The basic idea of the digital approach is to shoot one frame for the highlights, one frame for the shadows, then combine them in Photoshop. I call both the analog and digital versions of this approach to shooting high-contrast scenes the *Rembrandt Solution*.

I'll reserve a discussion of the science behind the Rembrandt Solution for the next chapter. I'll also hold off on discussing the digital version of the Rembrandt Solution until that time. Right now, let's discuss graduated neutral-density filters.

Split NDs, as I'll call them for short, are dark gray on the top half and clear on the bottom half. There's a gradual transition zone in the middle from dark

to clear. The dark half is a neutral density, meaning it does not shift colors. The filters are usually rectangular and fit into a holder that you attach to your lens via an adapter ring. The holder lets you slide the filter up and down and rotate it left or right. The concept behind these filters is simple: position the dark half of the filter over the bright part of the subject, usually the sky or a sunlit peak. The dark half of the filter holds back some of the light from the bright part of the scene so that your sensor can record better detail in the shadows and highlights. The filters come in different strengths, measured in the number of stops of light they subtract from the bright regions of the image. One-stop, two-stop, and three-stop filters are the most common, with two-stop filters being the most useful. They're also available with a variety of transition-zone widths for reasons I'll explain later in this chapter.

▲ FIGURE 6-26 Both of these graduated neutral-density filters subtract two stops of light from the bright areas of the image without shifting colors. Notice that the one on the left has a gradual transition from dark to clear, while the one on the right has an abrupt transition, known as a *hard stop*. The one on the right is longer so the transition can be placed very high or low in the frame without the edge of the filter being visible.

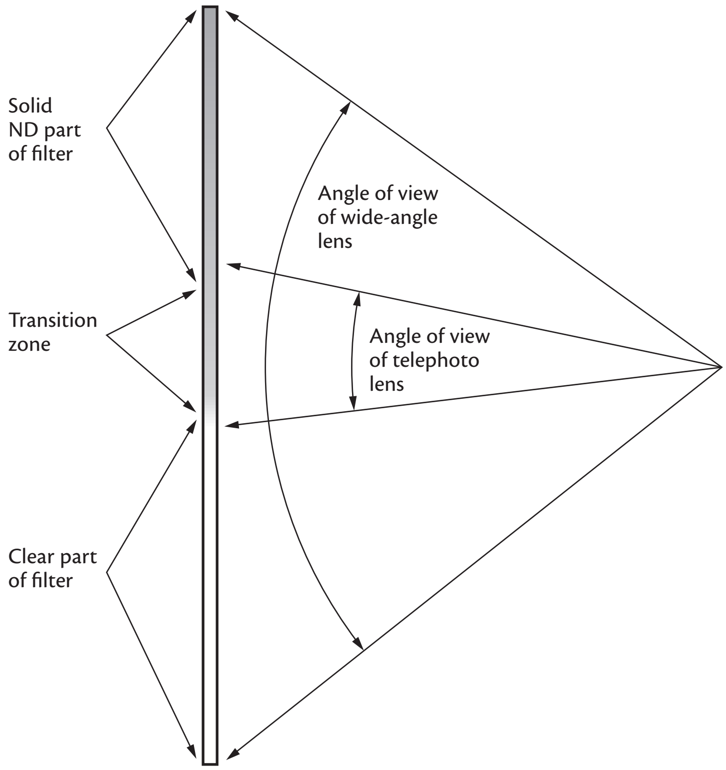
▲ FIGURE 6-27 This photo shows a graduated neutral-density filter mounted in a Lee filter holder, which is attached to the lens with an adapter ring

Split NDs are easy to use once you've learned three principles. First, always position the filter while looking through the lens *after* stopping down to the shooting aperture. In normal operation, DSLRs (and SLRs) give you through-the-lens viewing with the lens wide open, at its biggest aperture (smallest f-number, such as f/2.8 or f/4). The lens only stops down to the aperture at which you'll actually take the picture right before the shutter opens. That's useful when you're composing your picture because you see the brightest possible image. Looking through a wide-open lens is a problem, however, when using a split ND filter. When the lens is wide open, the transition zone from dark to clear will be too blurry to see how to position the filter.

The best solution is to use your depth-of-field preview button (if your camera has one). Pressing the depth-of-field preview button stops the lens down to the shooting aperture. The intended purpose of this feature is to show you how much of your photograph will be sharp at the aperture you have chosen. The unintended but useful consequence of pressing the depth-of-field preview button is that it makes the transition on the filter from dark to clear much easier to see if you set a small aperture, such as f/16 or f/22. It's also much easier to see if the filter is in motion. Here's my technique: I start with the filter high in its holder, press the depth-of-field preview button, then gradually slide the filter downward until it's positioned correctly, with roughly half the transition falling above the dividing line between highlights and shadows, and half below. As soon as I let go of the filter, the transition disappears again because our eyes have such a wide dynamic range that they instantly compensate for the diminished brightness of the highlight region.

The second principle of split ND use is that the width of the transition from dark to clear on the image, for any given filter, depends on the focal length of the lens. The width of the transition from dark to clear on the filter itself is, of course, a fixed dimension, but the effect of that filter on your image varies depending on the angle of view of the lens. With very wide lenses, the transition may be quite narrow. With normal focal-length lenses, or with short telephotos, the transition may occupy the entire height of the frame.

The best way to learn the width of the transition zone on the image is by making a simple, one-time test. Place your filter over the lens. Stop down to a small aperture, say f/16 or f/22, since those apertures will make the transition zone most obvious, and since those are the apertures you would normally use to achieve a deep depth of field in a typical landscape photograph. Now photograph an evenly lit, plain-toned wall that has no obvious texture or pattern. If your lens is a zoom, try a few representative focal lengths, such as 16mm, 20mm, 24mm, 28mm, and 35mm. You don't need to test each 1mm increment in focal length. Download the photos and take a look. Measure the width of the transition as a fraction of the frame and make a simple chart to carry in your camera bag.



▲ FIGURE 6-28 Diagram showing how one split ND filter will have very different effects on images shot with different focal-length lenses. Notice how the transition zone from dark to clear on the filter occupies only a small fraction of the angle of view of a wide-angle lens, but nearly the entire angle of view of a telephoto lens.

Once you know the width of the transition on your image for different focal lengths, you can choose the best filter for the situation. In general, soft-transition filters work best with wide-angle lenses, and hard-stop filters work better with longer focal lengths. If the boundary between shadow and highlight is irregular, consider a soft transition. If the boundary is straighter, consider a harder transition. When in doubt, try more than one filter to cover all your options.

The third principle for using split NDs is to find a band of naturally dark horizontal subject matter where you can hide the transition. For example, let's say you're shooting a field of wildflowers at sunset. The flowers are in shade, the mountains rising above are catching the last direct light, and there's a band of dark evergreens along the far side of the meadow where you can hide the transition zone on the filter. The trees are already naturally dark. Most people won't notice that you've made them a little darker.

Which Split ND Do You Need?

Here are my rules of thumb for deciding what strength of filter to use. In all examples, let's assume that the background is in full sun. If the foreground is shadowed by a thin cloud, I use a one-stop filter. If the foreground is shadowed by a thick cloud or by something solid (a cliff or mountain) and I'm looking away from the rising or setting sun, I generally use a two-stop filter. There are exceptions where a three-stop filter is necessary, like when my foreground is in the deep shade of a tall cliff or tall trees that are immediately behind me. I use a three-stop filter when I'm looking toward the rising or setting sun, or when the sun is in the frame. Precise decisions on which filter to choose and how to set the right exposure require spot metering, which I'll get to in the next chapter.

The Rembrandt Solution works well when there is a clean, simple separation of shadow and highlight detail. It fails when large, dark objects, like a shadowed tree, project upward against a bright sky. Your effort to darken the bright sky will inevitably darken the top half of the tree, which is also behind the dark part of the filter, creating what I call a "split ND artifact"—an unnaturally dark region of the image. Worse yet are subjects like a backlit arch at sunrise. A band of dark arch separates the bright sky visible above the arch from the bright sky showing through the arch. There's no good place to position the transition of your filter. You either fail to darken all of the overly bright sky, or you darken the top half of the arch unnaturally. In situations like these, you should consider the fourth exposure strategy: HDR.

▸ FIGURE 6-29 Graduated neutral-density filters work well in situations like this one because the dividing line between shadow and highlight is relatively straight, there is a dark band to hide the transition from dark to clear, and because no large dark elements, like a tree, project upward into bright regions

HDR

The last essential exposure strategy is HDR, an acronym for high-dynamic-range imaging. The basic idea is simple: shoot a bracketed set of exposures of the scene, then let a specialized piece of HDR software combine the correctly exposed parts of each frame into one perfectly crafted rendition of a high-contrast scene. You must bracket widely enough that the lightest frame has excellent shadow detail and the darkest frame has excellent highlight detail. The simplest approach is a three-frame bracket set with a two-stop bracket interval. With these settings, your camera will make three exposures in a row, and the exposures will be the metered exposure (0 exposure compensation), –2 exposure compensation, and +2 exposure compensation.

I'll have a lot more to say about executing the HDR approach in the next chapter. For now I just want to introduce the concept because it will help you understand the pros and cons of the Universal Exposure Strategy.

▾ FIGURE 6-30 HDR was the only solution for this image of Partition Arch at sunrise, Arches National Park, Utah

The Universal Exposure Strategy

In an ideal world, photographers would always have the leisure to carefully analyze which exposure strategy would give them the perfect result. But the world is imperfect, and the most promising situations are often fleeting. When I'm rushed, and *nothing is moving within the frame* (the big caveat), I often resort to the Universal Exposure Strategy. I set the camera to give me a five-frame bracket set with a one-stop bracket interval. A typical set, therefore, will have exposure compensation values of –2, –1, 0, +1, and +2. With that strategy, I can come away from the shoot confident that I have the data to choose, after the fact, which of the four basic exposure strategies will give me the best result.

In a PhD situation, the middle frame of the bracketed set (the metered exposure—0 exposure compensation) should be perfect. In fact, if you're completely confident it's a PhD scene, you don't need to bracket at all. However, as I showed in my image of the summer aspen grove in soft light (figure 6-12), even an intimate landscape on a cloudy day can be surprisingly high contrast, so I almost always bracket one stop over and under the metered exposure, even in a PhD situation. In a Limiting Factor situation, you always get your choice of the ideal exposure because you use a one-stop bracket interval instead of two. If you bracket with a two-stop interval, as is often recommended for HDR, you risk straddling the ideal exposure. One bracketed frame may be too dark, but the next frame in the set may be too light. The difference in exposure between frames is too great. Similarly, the Universal Exposure Strategy lets you choose the ideal two frames (the good-highlights frame and the good-shadows frame) when using the digital version of the Rembrandt Solution. And, of course, if you choose the HDR route, you can use all five frames in your favorite HDR software.

The big caveat with the Universal Exposure Strategy is that ideally nothing should be moving within the frame. If the subject moves in between frames and you try to use HDR software, you'll get ghosting: two translucent versions of the same object roughly stacked on top of each other but not perfectly aligned. HDR software offers tools to correct ghosting, but they're imperfect at best. Although it's less likely, you can have similar problems when using the Rembrandt Solution depending on where exactly the subject movement occurs within the frame.

▲ FIGURE 6-31 Stewart Peak, Baldy Alto, and Organ Mountain at sunrise from the summit of San Luis Peak, La Garita Wilderness, Colorado. To create this image I produced a 32-bit TIFF from my bracketed set of photos, then tone-mapped the TIFF in Lightroom.

What if your camera limits you to a three-frame bracket set? Here's a tip for efficiently shooting a five-frame bracket with a camera that will only do a three-frame bracket at one time:

- Set bracketing to three frames with a one-stop bracket interval
- Set exposure compensation to +1
- Shoot three frames, which will give you the series 0 exposure compensation, +1, and +2
- Now set the exposure compensation to –1 and shoot three frames

That will give you the sequence –2, –1, and 0 (again). You'll have one duplicate frame (the metered exposure—0 exposure compensation). Discard the duplicate and you've got a five-frame bracket set with a one-stop bracket interval.

Don't let the Universal Exposure Strategy become a crutch. Whenever possible, you should think through your exposures in the field. But when you're hypoxic and sleep-deprived on the summit of a 14,000-foot peak at sunrise (as I was repeatedly when shooting my book *Sunrise from the Summit*), and when nothing is moving in your foreground, the Universal Exposure Strategy can be an effective way to ensure you have all the pixels you need to create the most evocative possible image.

FIGURE 7-1 Wilson Peak and Gladstone Peak at sunrise from the summit of Mt. Wilson, San Miguel Mountains, Lizard Head Wilderness, Colorado

7

Digital Capture and Processing of High-Contrast Scenes

Many of the most dramatic landscape photographs are taken in high-contrast light, with sunrise or sunset light stabbing through the clouds and spotlighting a distant peak or sandstone tower, leaving the equally important foreground in deep shadow. Capturing a full range of tones in such high-contrast situations and reproducing them in a way our visual system considers natural has challenged landscape photographers ever since photography was invented nearly 200 years ago.

High-contrast scenes are difficult to photograph because of differences between our complex visual system and a camera's sensor. Our eyes can see a huge range of light intensities from brightest highlight to darkest shadow. However, the range of brightness levels in a print is limited by the amount of light reflected by even the brightest white paper or canvas and by the amount of light absorbed by the blackest ink or paint available. The range of light intensities in the real world, in one scene, can be 10 or even a hundred times greater than what can actually be reproduced in a print. As you'll see, the problem is compounded because our visual system does not analyze contrast globally, but rather within regions. A straightforward linear compression of the tonal scale we see into one we can print looks quite unnatural because it doesn't correspond to the way our visual system processes high-contrast scenes.

This problem is not new. In the preceding chapter I mentioned the Rembrandt Solution, my term for a photographic technique that employs the same principles as counter-shading, the technique that Rembrandt developed for creating the illusion of greater dynamic range than actually existed in a painting. I also described how you could achieve the same result with graduated neutral-density filters. In this chapter, I'll describe how you can use Photoshop to create the same effect with much greater flexibility and precision than is possible with physical filters. This chapter will also teach you the principles of perception that underlie this technique. I will discuss how our visual system processes high-contrast scenes, which will give you insight into how to craft photographs that look both believable and beautiful. With that information to guide you, I'll then show you how to use the Rembrandt Solution within Photoshop to merge two separate exposures of a scene—one exposed for highlights, one exposed for shadows.

▲ FIGURE 7-2 I used the Rembrandt Solution to assemble this image of Peak 13,242, columbines, and Blue Lake, Mt. Sneffels Wilderness, San Juan Mountains, Colorado

Countershading

Understanding counter-shading is fundamental to understanding the Rembrandt Solution. Counter-shading is the technique of introducing a gradual change in the background illumination, let's say from light to dark, so that light foreground elements placed against the dark part of the background look brighter than they actually are. Counter-shading relies on two principles. The first is that our visual system is much more sensitive to abrupt changes in luminosity than gradual ones. In other words, our eyes are programmed to look for edges of objects. Our visual system evolved this way because it was much faster, for example, to identify the outline of a lion

◂ FIGURE 7-3 The circle-gradient illusion. The two circles are exactly the same in reality, but they look different because one is surrounded by a gradient from dark gray to light gray, while the other is surrounded by pure white.

hiding in tawny brush than it was to distinguish the texture of fur from the texture of grass. The second principle is that surrounding a tone with something darker makes the original tone seem lighter; surrounding the original tone with something lighter makes it seem darker. Vision scientists call this effect simultaneous brightness contrast.

Figure 7-3 shows a simple example of counter-shading called the circle-gradient illusion. When a background gradient is present, as in the left-hand image, you should see a subtle gradient inside the circle, from lighter on top to darker on the bottom. When the background is pure white, as in the right-hand image, you can see that the circle is actually a completely even tone. Simply by creating a tonal gradient in the background, we've induced an apparent, opposite tonal gradient in the foreground.

Now let's take it further, to an example that shows how both the digital and analog versions of the Rembrandt Solution can create the illusion of greater dynamic range. Take a look at figure 7-4, which shows the Cornsweet illusion. The left half of the figure shows two rectangles, one above the other. The top rectangle should appear lighter than the bottom. In the right half of the figure, the middle two quadrants of the diagram are hidden. Suddenly you see that, in reality, the top quadrant of the strip is exactly the same shade of gray as the bottom quadrant.

Here's what's going on: The top half of the illusion actually contains a gradient from midtone to lighter-than-midtone. The bottom half contains a gradient from darker-than-midtone back up to midtone. Our eyes are insensitive to the gradual change of density in the gradients, but very sensitive to the abrupt change of density in the middle. Here's the crucial point: merely by introducing two simple gradients, you can create the illusion of a greater dynamic range than actually exists. The top and bottom quadrants of the illusion are, in reality, the same density, but they look different. The Cornsweet illusion shows why you can use a split ND filter with a gradual

▲FIGURE 7-4 The Cornsweet illusion. In the gray strip at the top, the far left and far right ends are exactly the same tone, although they appear different because they are joined in the middle by a gradient. The two lower squares are copied from each end of the rectangle. As you can see, their tones are identical. If you cover the middle gradient of the top strip with your finger, you'll see that all four boxes are the same color.

transition from dark to clear in a situation where the actual transition from highlight to shadow is abrupt—and not only hide the fact that you've used such a filter, but actually enhance the apparent dynamic range of your print. The digital equivalent of using a split ND works exactly the same way.

Picture a typical split ND situation, with brightly lit mountains and deeply shadowed foreground flowers. You attach a split ND filter with a gradual transition zone from dark to clear and position the middle of the transition zone over the sharp dividing line between shadowed flowers and sunlit peaks. Let's analyze the situation in the captured file as we move from top to bottom along the filter. Figure 7-5 shows an example. The solid gray part of the filter uniformly darkens the upper part of the peaks. As the filter's transition from dark to clear begins, the sunlit peaks actually become brighter as the amount of light absorbed by the filter diminishes. At the shadow line, still beneath the transition zone of the filter, the shadow becomes darker than it otherwise would be because the filter's transition zone hasn't yet faded to clear. The bottom of the scene is unaffected because it's behind the clear portion of the filter. A print of the image will show the illusion of a greater dynamic range than actually exists. As you'll

soon see, the digital version of the Rembrandt Solution achieves the same effect using slightly different means.

How our Visual System Processes High-Contrast Scenes

Now let's talk about how our visual system processes high-contrast scenes. You might think that we analyze contrast globally; in other words, you might think that we look at the darkest part of the scene and call it black, then look at the brightest part of the scene and call it white—but that's not actually how we see. In high-contrast situations, our visual system divides the scene into various zones and analyzes the local contrast in each zone independently. Shadows and highlights are the most obvious zones, but we also create zones more subtly. We then assign brightness values within zones, and don't really pay much attention to brightness differences across zonal boundaries. For a scene to look natural, the local contrast must look right *in*

▾ FIGURE 7-5 Illustration showing how split NDs affect the density of an image

each zone. When you use the Rembrandt Solution (either analog or digital), you can expose both the highlight and shadow regions somewhere close to midtone, which means both regions will have near-ideal contrast and color. Then, by using a Cornsweet illusion-like pair of tonal gradients, you can marry the two regions in a way that our visual system finds believable.

For an illustration of how our visual system analyzes local contrast rather than global contrast, check out the optical illusion in figure 7-6. Examine the two thin rectangular regions I've outlined, one containing a strip of white paper in the shade, the other containing a portion of the second letter "l," printed in black ink, in the sun. The white paper in the shade looks significantly brighter than the black ink in the sun. How could it be otherwise? Isn't white paper always brighter than black ink? Now look at the copies of the same two rectangles that I've placed to the right of the photograph of the newspaper. You'll see that the white paper is actually much darker than the black ink. The two rectangles shown in isolation are exactly the same density as the two rectangles outlined in the photograph of the newspaper, but they look different because they are isolated against a plain white background rather than placed inside the context of an image with clearly defined highlight and shadow regions.

You might think it would be better to show only the perfectly exposed highlights and shadows, without having a gradual transition between the highlight and shadow regions. In fact, it's better *not* to create a hard edge between the highlight and shadow regions because the transition between the two regions will look more natural if you don't. Creating a hard edge between the two regions leads to an abrupt transition from cool shadow to warm highlight that has a color change but no density change. Your brain can be fooled, but it's not stupid: the result looks patently fake, as you can see in figure 7-7.

▾ FIGURE 7-6 Newspaper local-contrast illusion

Capturing Rembrandt Solution Images in the Field

Enough theory! Let's take these ideas and put them to practical use. In chapter 6, I discussed how to use physical split NDs. Now let's talk about creating the digital equivalent. To use the digital version of the Rembrandt Solution, you need to make two captures, one correctly exposed for the highlights, the other correctly exposed for the shadows.

▲ FIGURE 7-7 Creating a sharp boundary between the highlight and shadow regions of an image, with each region exposed close to midtone, leads to an obviously unnatural result. Compare this image to figure 7-5.

For starters, be sure to lock your camera down on a solid tripod, and be careful not to move the tripod or camera when adjusting the exposure. When changing exposure, be sure to change the shutter speed, not the aperture. Changing the aperture will change the depth of field, which will prevent the images from aligning perfectly. Using the auto-bracketing feature on your camera makes the job much easier. In aperture priority and manual exposure modes, most if not all cameras will auto-bracket by holding the aperture constant and varying the shutter speed—exactly what you want. In shutter-priority or time-value mode, they will hold the shutter speed constant and vary the aperture—*not* what you want.

The procedure for calculating the two digital exposures is similar in concept to the rigorous method for choosing the correct strength of a split ND filter. Let's start with the digital procedure, using the example of a field of wildflowers in shade with a peak in the background catching the last rays of the setting sun. I start by calculating the correct exposure for my foreground using either a hand-held or in-camera spot meter.

To understand spot metering, first recall that reflected-light meters always recommend an exposure that will render whatever you meter as a middle tone. If the subject is midtone, such as green grass or deciduous foliage, then the meter's recommendation will be dead-on. That's true whether you're using an overall meter pattern that reads the whole scene, such as evaluative (Canon's term) or matrix (Nikon's term), or whether you're using spot metering. Spot metering merely confines the meter reading to the small portion of the subject visible through the spot metering circle in your viewfinder.

▲ FIGURE 7-8 I made this image of Windom Peak, Sunlight Spire, and Sunlight Peak from South Sunlight Lake at sunrise, Weminuche Wilderness, Colorado, using a physical split ND filter and 4 × 5 film

Since my foreground in this example has lots of midtone green foliage, I spot meter the foliage and use manual exposure mode to set the exposure recommended by the meter on the camera. This is my base exposure, which will perfectly expose everything in the foreground. For the moment, I don't care what happens to my background.

With my foreground exposure locked in, I calculate the correct background exposure. Let's say I meter the sunlit peak at 3 stops brighter than my foreground flowers. For example, I might meter the foreground foliage at 1/2 second, f/16. I then meter the sunlit peak at 1/15 second, f/16. That's a three-stop difference. When I make the first capture at my base exposure (the correct exposure for the foreground), the sunlit peak will be three stops overexposed and I will get a very pale, washed-out peak. The sky, which is usually even brighter, will be completely white. I need to make a second

exposure that renders that peak only one stop brighter than midtone. Since my base exposure places the peak three stops over midtone, that means I need a second exposure that will be two stops darker than my base exposure. So I engage auto-bracketing on my camera and set the bracket interval to two stops. I then choose a two-frame bracket set, and set the bracket order to normal, under, over. Since the bracket set only contains two frames, the camera won't actually shoot the over frame. (If your camera doesn't offer a two-frame bracket set, use a three-frame bracket set and just discard the grossly overexposed over frame once you've downloaded your images to your computer.) I always shoot the normal exposure first because I usually have to wait for the wind to stop. The normal exposure will be the one with correctly exposed flowers. I want to nail that exposure first while the flowers are completely still.

Why not bring the exposure for the sunlit peak all the way down to midtone? Primarily because it would look unnaturally dark and rich. It's a highlight; it should be brighter than midtone.

▾ FIGURE 7-9 I made this image of heartleaf arnica and Uncompahgre Peak at sunset, Uncompahgre Wilderness, Colorado, using a graduated neutral-density filter and 4 × 5 film

If I was using physical split ND filters, I would choose a two-stop filter, which reduces the exposure for the mountain by two stops, rather than making a second exposure that was two stops darker than the first.

If all this talk of spot metering has you seeing spots, consider this: in a Rembrandt Solution situation, the difference between the correct foreground and background exposure will almost always be between two and three stops. If you calculate a one-stop difference, your camera can almost certainly straddle the range of brightness levels present in the scene. If you calculate a four-stop difference, you probably won't be able to merge the two images without the transition line being obvious. If the difference is four stops, you're in an HDR situation.

At this point you may be wondering, "Why not just use the Universal Exposure Strategy? That'll cover all the bases." The problem with the Universal Exposure Strategy in this case is that the compromise exposure recommended by the meter for the scene overall will attempt to straddle the difference between the bright highlights and the dark shadows and do justice to neither. This unacceptable compromise exposure will be the first one the camera makes. By the time the camera gets around to making the correct exposure for the flowers, the wind may be blowing again and the flowers may be blurred.

Merging the Images in Photoshop

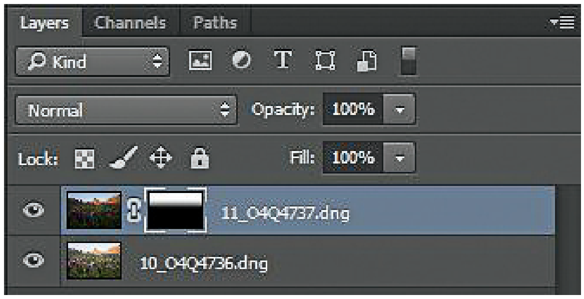
In the directions that follow, I'll assume you're using a PC. Mac users should substitute the Command key for the Control key.

The first step is to load the two exposures as layers in a single file in Photoshop. The easiest way to do this is to start from Lightroom. In Lightroom, select both images, then choose Photo>Edit In>Open as Layers in Photoshop. If you don't use Lightroom, start from Bridge (which ships with Photoshop). Select both images, then choose Tools>Photoshop>Load Files into Photoshop Layers. And if you don't use Bridge, then start from Photoshop itself. Choose File>Scripts>Load Files into Stack and navigate to the appropriate files.

Whichever method you use, the next task is to drag the dark (good highlight) layer to the top of the layer stack if it's not already there.

Target the highlight (top) layer and add a layer mask to it by clicking the Add Layer Mask icon at the bottom of the Layers panel. It looks like a square with a circle inside it. Be sure your foreground color is white and background color is black. (Press D for default colors of white and black.) Be sure you've targeted the layer mask, not the image itself, by clicking on the mask. Select the Gradient tool (hit G on the keyboard). Click the Gradient icon (far-left icon in the Options bar) and make sure you have foreground to background

selected. Drag out a gradient in the image window, starting where you want the transition from white to black to begin, and ending where you want the transition to end. Photoshop will fill in the mask with solid white above the starting point of your drag and fill it in with solid black below the ending point of your drag. White areas of the mask reveal the corresponding portion of the layer to which the mask is attached; black areas conceal that portion. Gray areas partially hide that portion of the layer, allowing some portion of the layer beneath to show through. Figure 7-10 shows what the Layers panel should look like. Your image should now show the best parts of each layer, with an unobtrusive transition between the highlight and shadow regions. If it doesn't, just redraw the gradient. There's no need to hit Control-Z to undo the first version. Photoshop will replace the first version with the new one. You can do this as many times as you like.



▲ FIGURE 7-10 The Layers panel after completing the Rembrandt Solution

If necessary, refine the mask by painting on it with either white or black to achieve the final result. Press B to get the Brush tool. With the mask still targeted, paint with white to reveal more of the good-highlight region. Paint with black to reveal more of the good-shadow layer. Press the backslash key to see a translucent pink overlay of the mask. The pink overlay corresponds to black areas on the mask.

The image I chose for the example above works perfectly for this simple form of the Rembrandt Solution. The dividing line between highlight and shadow is nearly straight, and there are no large dark elements, like trees, that poke up into the highlight region. But what if the dividing line between highlight and shadow is irregular rather than nearly straight? The simple approach doesn't work, as you can see in figure 7-11. Here's how to handle even this extreme example.

▸ FIGURE 7-11 This photo shows the result of using the Rembrandt Solution, whether analog or digital, with a straight dividing line between dark and clear portions of the filter, or the white and black portions of the layer mask. Notice that the sunlit mountains and shadowed flowers are correctly exposed, but the shadowed valley walls on either side of the frame are too dark.

▲ FIGURE 7-12 The image after drawing the selection and adding a layer mask

Start by opening and stacking both images with the dark image on top, as before. Now, instead of adding a layer mask, press L for the Lasso tool. Draw a selection around the highlight region. You don't need to be too fussy about making it perfect. In fact, you should draw the selection well down into the shadow region where the skyline is the boundary between highlight and shadow to avoid creating a halo (an unnatural bright region along the skyline) when you blur the mask in the final step. Add a layer mask by clicking the Add Layer Mask icon at the bottom of the Layers panel. Photoshop will automatically make the selected area white on the mask and black everywhere else. The image will look very odd, as shown in figure 7-12.

Now let's make the image look natural. With the mask targeted, go to Filter>Blur>Gaussian Blur and blur the mask. You'll need a high Radius, probably between 100 and 250 pixels, depending on the resolution of your image and how much you want to blur the mask. Click OK, and you'll see that you've effectively blurred the mask, which in turn has softened the transition from the highlight to the shadow region. You can touch up the mask as needed by painting on it with either black or white. In effect, you've just created a custom split ND filter that follows the boundary between light and shadow.

Smart Objects and the Masks Panel

Two additional Photoshop features, Smart Objects and the Masks panel, give you still further control and flexibility when using the Rembrandt Solution. Smart Objects have many uses, but the most important for our purposes is that they allow you to edit the contents of an individual layer using all the tools available in Adobe Camera Raw. The Masks panel, which became part of the new Properties panel starting with Photoshop CS6, allows you to blur a mask nondestructively. You can reopen the image at any time and change the amount of blur.

You can implement these two features starting from either Lightroom or Bridge. In Lightroom, select the two images you want to work with and

▲ FIGURE 7-13 The final result

choose Photo>Edit In>Open as Smart Object in Photoshop. In Bridge, select the two images and double-click one of them to open both in Camera Raw. Select both files using the Select All button on the top left, then hold down Shift and click Open Object. The two files will open in Photoshop as Smart Objects.

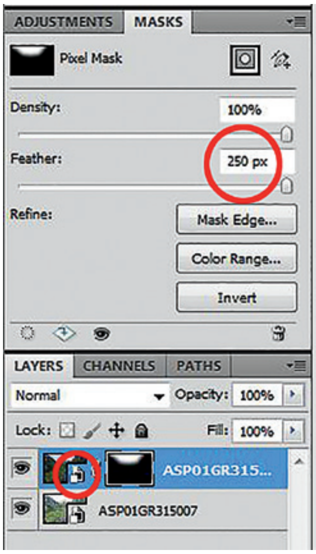
If you're using a tabbed interface (the default), each image will be open under its own tab. Click the tab for the good-highlights image (the darker one, with good highlight detail but dark shadows) to make it active. Press Control-A to select all, then choose the Move tool (press V). Hold down Shift, and drag the good-highlights image up to the tab for the good-shadows image. Don't try to drop it there; instead, wait until Photoshop switches to the good-shadows image, then move the cursor down over the good shadows image and release the mouse button. Now (finally!) you can release the Shift key. By holding down Shift, you tell Photoshop to align the two images precisely.

Proceed as before by drawing a selection around the highlights with the Lasso tool and adding a layer mask. The image will look awful. Now open the

Properties panel, which contains the Masks panel. If it's not visible, choose Window>Properties. With the mask targeted, adjust the Feather setting in the Masks panel. Use a high radius (100 to 250 pixels, depending on the image and the resolution of your camera). This will blur the mask and soften the transition between the highlight and shadow regions.

There is one important caveat about using the Feather slider in the Masks panel to blur the mask. The Feather setting controls both the amount of blur applied to the mask *and* the amount of blur applied to any subsequent painting you may do on the mask to refine the mask edge. If you choose a small, soft-edged brush and have a high radius set with the Feather slider, your brush may be so blurred that it essentially has no effect. Trying to paint on a mask with the Feather slider set to a high value is also very processor-intensive. Your machine may slow down to the point where you assume it has frozen. If you need to further adjust the mask after blurring it with the Feather slider in the Masks panel, try this procedure: first, note the setting of the Feather slider that works best with your image. Then reset the Feather slider to zero. With the mask targeted, go to Filter>Blur>Gaussian Blur and blur the mask using the same setting you initially used for the Feather slider. Now you can paint on the mask with predictable and near-instant results. The disadvantage of this procedure is that once the file has been saved and closed, you can't undo the mask blurring as you can with the Feather slider in the Masks panel, although you can, of course, correct mistakes by further painting on the mask.

If you want to make further adjustments to the RAW files, you can double-click the Smart Objects icon inside the layer thumbnail of the appropriate layer in the Layers panel. This will reopen the image in Camera Raw and allow you to make any further changes. Click OK to close the Camera Raw dialog box. Photoshop will reopen with your changes in place. Note that changes to a Smart Object will not be reflected in the Develop settings for the original RAW, which will retain the Develop settings in place when you first opened the file as a Smart Object. The Spot Healing Brush and Clone Stamp tool won't work directly on a Smart Object. It's easiest to clean your images in Lightroom or Camera Raw before opening them in Photoshop as Smart Objects, but you can also use this workaround: add a new, blank layer at the top of the layer stack (Control-Shift-N). If you're using the Clone Stamp tool, set Sample to All Layers in the Options bar. If you're using the Spot Healing Brush, check Sample All Layers. Both tools should now work.



◂ FIGURE 7-14 The Masks panel showing a feather setting of 250 pixels. The Smart Objects icon is circled.

Final Thoughts on the Rembrandt Solution

Which is better: a physical split ND filter or the digital equivalent? Certainly you'll find the physical filters useful if you're still shooting with film. If you're shooting digitally, but don't use either Photoshop or Photoshop Elements, particularly if you're capturing images as JPEGs, you will find split NDs very useful. Lightroom doesn't support layers, so it can't be used by itself for this procedure. If you are comfortable using either the full version of Photoshop or Photoshop Elements, particularly if you are capturing images as RAW files, and if you're familiar with the high-dynamic-range techniques I'll describe next, you may find that digital techniques for merging two or more images taken at different exposures have made split NDs obsolete. Split NDs do have one significant advantage over all of the digital techniques: they allow

▾ FIGURE 7-15 I shot this image of sunrise over an aspen grove on Beaver Mountain, Rocky Mountain National Park, Colorado, using 4×5 film and a three-stop graduated neutral-density filter

you to record the full range of tones present in the scene in a single capture, eliminating the problem of scene elements, such as flowers, leaves, or water, moving in between exposures. And they save time at the computer—time that can be spent more enjoyably in the field. For me, however, the flexibility and control offered by the digital techniques outweigh the advantages of physical filters. I carried a quiver of eight split ND filters for 15 years when I was shooting 4×5 film, but I retired the kit for good when I bought my first high-end DSLR.

The same landscapes that work well with physical split NDs are good candidates for the digital version of the Rembrandt Solution. In situations that lend themselves to this technique, the digital Rembrandt Solution can quickly produce results that are both realistic and beautiful. While subject movement can be a problem, it's often easier to manage movement using this approach than it is when using HDR software. Let's say the wind never stops completely, so that a few blossoms are blurred, even in your very best frame. If you use the Rembrandt Solution, only one layer (the good-shadow layer) is visible in the image region containing the flowers. You will see slight motion blur in the blossoms that moved during the exposure, but you won't see totally unnatural ghosting, with two versions of the same blossom faintly visible through each other—as can happen with HDR software. The only region where motion could be a problem is under the transition zone between the two images. Usually that can be placed on the mid-ground or background, where it's unlikely that subject movement will be noticeable.

My first choice when shooting high-contrast scenes is to try to get all the detail I need in a single capture. If the dynamic range of the scene exceeds the range of my sensor, I turn next to the Rembrandt Solution. If that approach won't work, I resort to high-dynamic-range software.

HDR: Great Potential, Many Pitfalls

Interest in high-dynamic-range imaging has exploded over the last five years. More than half a dozen HDR programs are available today, and more seem to pop up every week. HDR imaging promises to solve one of the great challenges of photography—taking the broad range of tones we see in the real world and compressing it into the much narrower range of tones we can see on a monitor or reproduce on paper.

Until recently, however, I was an HDR skeptic. All too often, HDR software produced unnatural results. Shadow contrast sometimes looked strangely flat. Colors shifted in unexpected ways and dark objects set against bright backgrounds often developed pronounced halos—weird bright bands along

the object's edge. Textures were often enhanced beyond the bounds of believability.

Granted, HDR software must solve a tough problem: replicating the intricacies of human vision. As I discussed earlier in this chapter, our visual system analyzes contrast locally rather than globally. In other words, we don't look at the darkest part of the overall scene and call it black, then look at the brightest part and call it white. Instead, we analyze contrast within regions, most obviously shadows and highlights, but also more subtly. The challenge for HDR software is to maintain good local contrast within regions, while

▲ FIGURE 7-16 A sea of fog fills the valley of the Arkansas River as seen from the summit of Mt. Princeton at sunrise, San Isabel National Forest, Colorado. To create this image, I produced a 32-bit TIFF from my bracketed set of photos, then tone-mapped the TIFF in Lightroom.

▲ FIGURE 7-17 Aspen grove on top of Stealey Mountain at sunset, near Owl Creek Pass, San Juan Mountains, Colorado. To create this image I used my favorite HDR technique: producing a 32-bit TIFF from my bracketed set of photos, then tone-mapping the TIFF in Lightroom.

still creating believable transitions across regional boundaries. Simply taking the overall range of tones and squashing it down to a range we can print produces an odd, low-contrast image no one would call realistic.

The latest generation of HDR software goes a long way toward solving these problems. My current favorite approach is using Lightroom to tone-map 32-bit TIFFs. Before tackling this approach in detail, however, let's dive a bit deeper into the concept behind HDR. The number of brightness levels a digital image can contain is determined by its "bit depth." JPEGS, for example, are 8-bit images, which means they can contain 256 brightness levels (shades of gray, in black-and-white terms), from solid black to pure white. Most DSLRs capture RAW files in 12 or 14 bits, which is then interpolated up to 16 bits. A 16-bit Photoshop file can contain 32,769 brightness levels. (The mathematically inclined among my readers will have noticed that 16-bit Photoshop files actually only have 2^{15} brightness levels for technical reasons we don't need to get into here.) While greater bit depth doesn't directly translate to greater dynamic range, it does help preserve smooth tonal gradations in high-contrast images. A 16-bit file can cover a broad brightness range, but it's still not enough to cover the full dynamic range of a high-contrast scene.

▴ FIGURE 7-18 Frosted ponderosa pines at sunrise, Flagstaff Mountain, Boulder Mountain Parks, Colorado. Created by tone-mapping a 32-bit TIFF in Lightroom.

HDR images are 32-bit images, which can contain far more brightness levels than 16-bit images—enough to cover the full dynamic range of the highest-contrast scenes we encounter. Unfortunately, HDR images contain such an enormous range of brightness levels that no conventional monitor can display them, and we'll probably never be able to print them using ink on paper. Before an HDR image is usable, it must be *tone-mapped*. In other words, the dynamic range of the image must be intelligently compressed into a range we can display on a monitor and then print. HDR programs differ both in the quality of the initial 32-bit file they produce and in the quality of their tone-mapping algorithms.

Setting up an HDR Image

Now let's discuss the procedures you should follow in the field when you're planning to use the HDR approach. As with the Rembrandt Solution, be sure to lock your camera down on a solid tripod, and be careful not to move the tripod or camera when adjusting the exposure. When changing exposure, be

sure to change the shutter speed, not the aperture. Changing the aperture will change the depth of field, which will prevent the images from aligning perfectly.

At a minimum, you should bracket high-contrast scenes in a set of three, with a bracket interval of two stops. In other words, shoot a frame at –2 exposure compensation, then 0, then +2 stops. For the highest-contrast scenes, such as those with the sun in the frame, you will get slightly better results if you shoot seven frames at a 1-stop bracket interval. This covers a range from –3 stops to +3 stops rather than –2 to +2. The very darkest of these exposures will have slightly better detail in the sky around the sun, which will be noticeable in the final print.

▲ FIGURE 7-19 Mt. Sneffels in late September from County Road 7, San Juan Mountains, Colorado. Created by tone-mapping a 32-bit TIFF in Lightroom.

HDR software is always improving. If you capture a wide range of exposures today, you may be able to improve your rendition of the image in the future as the software becomes more capable. Regardless of how many frames you shoot, be sure to check your histogram after your first bracketed sequence to be sure you have at least one frame with excellent shadow detail and one frame with excellent highlight detail. Ideally, your lightest shadow frame should be light enough that most of the shadow region falls in the midtones. This helps suppress the noise buildup that can plague images generated with HDR software.

In most situations you can let the camera pick the starting-point exposure, then bracket around that setting. With certain subjects, however, that approach will fail. Let's assume you're working on a shot where 80 percent of the frame is shadowed rock and 20 percent is ultra-bright sky. Your meter will recommend an exposure that will render the dominant subject—the shadowed rock—as a midtone. That's all the detail you need in those dark rocks; you really don't need any lighter exposure for the shadows. However, if you're bracketing around the zero exposure-compensation mark, your camera will then make an exposure two stops brighter and an exposure two stops darker. The +2 exposure is unnecessary (not a big problem) but the –2 exposure may not be dark enough to bring in all the detail you want in that bright sky (a very big problem). The solution? Set your exposure com-

pensation to –1, and bracket around that starting point. That gives you –3, –1, and +1 as your three exposures. You'll still have plenty of shadow detail, and you've brought in the highlights as well.

▸ FIGURE 7-20 If your subject is predominately dark with a very bright strip of sky, like this view from the summit of Mt. Evans, set the starting point for your bracketed series at −1 exposure compensation

Similarly, if the shot involves 80 percent bright sky and 20 percent dark land, the meter will recommend an exposure that will render the sky as a midtone, which is adequately dark. If you're bracketing around the zero exposure mark, however, you'll get a frame that's two stops darker (unnecessary, but not a big problem) and a frame that's two stops lighter, which may not be light enough to give you the detail you want in the land (a very big problem). The solution is to set your exposure compensation to +1 and bracket around that starting point, giving you –1, +1, and +3 as your bracket set. You'll still have plenty of highlight detail, and you'll have adequate shadow detail as well.

Bottom line: if the scene is predominately dark, bias your starting-point exposure toward dark (–1 exposure compensation); if the scene is predominately light, bias your starting-point exposure toward light (+1 exposure compensation). Then check the histogram for each frame in the bracket set to make sure you have adequate highlight detail in your darkest frame and adequate shadow detail in your lightest frame.

▾ FIGURE 7-21 If your subject is predominately bright with a thin strip of dark land, like this view from the summit of Mt. Shavano, set the starting point for your bracketed series at +1 exposure compensation

Tone-Mapping in Lightroom

Once you have a well-exposed set of images, the next task is to combine them into a 32-bit file. All of the standalone HDR programs, as well as Photoshop, include a utility to perform this chore without user input. The various HDR programs then provide you with a bewildering variety of ways to tone-map the 32-bit file so it can be displayed on a monitor and printed. These programs are good, and may have improved further by the time you read this, but right now tone-mapping your 32-bit TIFFs in Lightroom is the best option.

I always prefer software workflows that are intuitive. That's one major reason I like to use Lightroom to tone-map my HDR files. I can use all of Lightroom's powerful, sophisticated, and familiar controls in a completely nondestructive manner while getting full access to the enormous range of tonal data in the 32-bit file. If you shoot in high-contrast light but hate the surreal HDR look, the Lightroom approach is something you've got to try.

This approach does have a catch. As of this writing, Lightroom doesn't have the capability of creating a 32-bit TIFF from a bracketed set of images. (At this time, Lightroom can only manage 32-bit TIFFs, not 32-bit files in any other format.) To create the 32-bit TIFF, you'll need Photoshop, Photomatix Pro (most easily used as a stand-alone program—not accessed through Lightroom), or the Merge to 32-bit HDR plug-in for Lightroom created by HDRSoft, the same company that makes Photomatix. By the time you read this, Lightroom may be capable of creating a 32-bit TIFF, and other methods may be available as well. Be sure to check out all the options. Creating a 32-bit file is not a turnkey operation, and the quality of the file varies considerably from program to program. Shots with the sun in the frame pose a particular challenge because the extreme difference in brightness levels makes it difficult to create smooth, believable gradients across the sky.

▾ FIGURE 7-22 Snowmass Mountain and Capitol Peak from the summit of 14,156-foot South Maroon Peak at sunrise, Maroon Bells-Snowmass Wilderness, Colorado. Created by tone-mapping a 32-bit TIFF in Lightroom.

Regardless of the method you use to create the 32-bit file, the next step is the same: open the image in Lightroom's Develop module. The first thing you'll notice is that the Exposure slider in the Basic Panel now provides a range from –10 to +10 stops. For an ordinary RAW file, the range is just –5 to +5 stops. That gives you an idea of just how much data you get to play with. Don't expect to do all the work with the Exposure slider, however. You'll probably need to make some large adjustments of the Shadows, Blacks, Highlights, and Whites sliders to bring out all the detail in the file. Many 32-bit images benefit from adding contrast in the Tone Curve panel, and you may need to further adjust shadow and highlight density with the Graduated Filter and Adjustment Brush. You'll find that you can recover more clean, usable detail, even in the darkest shadows and brightest highlights, from a 32-bit image than you can from a 16-bit RAW file. And it's all nondestructive. You can return to the image at any time to make further refinements. If your goal is to create natural-looking images of high-contrast scenes, you're going to love this approach.

Keeping it Real with HDR

Despite all the advances in HDR software in recent years, achieving a natural-looking result can still be a challenge. In fact, one of the questions students most frequently ask in my landscape photography workshops is, "How do I make my HDR photographs look more realistic?"

▾ FIGURE 7-23 Beaver Lake and aspens, near Silver Jack Reservoir, San Juan Mountains, Colorado. Created by tone-mapping a 32-bit TIFF in Lightroom.

To answer that question, we first need a clear understanding of the problem. As I've discussed, we'll never be able to create an image on paper that displays the full dynamic range we can see in the real world. In that sense, it's impossible for a print to ever look completely real. But it is possible to get close—close enough that a print evokes in the viewer many of the same emotions that the real scene evoked in the photographer.

My guide when preparing prints has always been what I saw, rather than what my film or sensor captured. I was never satisfied with the limited dynamic range of my 4×5 film,

for example, and I carried eight graduated neutral-density filters to try to capture shadow and highlight detail the way I saw it. When affordable film scanning became available, I began using Photoshop to further adjust shadow and highlight density. Digital capture was another step forward, but even the high-end DSLR I'm using today still has less dynamic range than my eyes, which is why I use a variety of digital techniques, including HDR, to capture what I see.

But how do you really know what you saw hours, days, or weeks later? According to RIT professor Mark Fairchild, people are notoriously bad at remembering colors. We can distinguish thousands of different colors if they are placed side by side, but we can accurately remember less than a hundred. We can easily remember if the flowers were blue or red, for example, but we quickly forget what shade of pink we saw in sunset clouds. To further muddy the waters, according to Fairchild, people tend to remember colors as more saturated than they actually were. In addition, we tend to substitute certain "memory colors" for common objects. For example, we remember yellow-green grass as more green than it actually was, and we tend to remember sky as pure blue when it actually wasn't. Your best guide to what you saw is your original bracketed set of images—with one qualification.

Let's assume you've loaded a bracketed set of images into your favorite HDR software. As you begin to adjust the 32-bit file, compare the region you're working on to the frame from your bracketed set that is properly exposed for that region. If you're adjusting the portion of the image that contains flowers, for example, "properly exposed" may mean the frame in which the green foliage surrounding the flowers was rendered as a midtone. If you're adjusting a sunset sky, however, don't pick the frame in which the glowing clouds are midtone and everything else is black. As pretty as those clouds may be, they're underexposed. Glowing clouds are a highlight; they should be brighter than midtone. Midtone clouds will look unnaturally dark if placed in a landscape where the flowers beneath are also midtone.

Here are some other key principles for making your HDR photos look more realistic:

- **Keep saturation under control:** Wildly oversaturated colors may catch your viewer's eye, but excessive color saturation looks unnatural and is a flimsy reed on which to hang the entire impact of your image.
- **Let highlights be highlights:** As Margaret Livingstone, a neurobiologist and vision researcher at Harvard Medical School points out, "We don't actually perceive the amount of light at any point in a scene, but instead we perceive the relative amount of light at each point, com-

pared to that point's immediate surround." Explaining further, she added, "Something looks light only if it is lighter than its background." Photographs of high-contrast scenes generally look more realistic if the brightest tones are close to pure white but not clipped on the histogram. Images containing the sun are an exception. The disk of the sun itself will always be blank white unless it is partially concealed behind dense fog or clouds. In a clear sky, the sun can cause *veiling flare* in our eyes as well as our lenses. Veiling flare, an overall diffuse, washed-out appearance in an image, occurs when the sun is shining directly on the lens surface, even if the sun is outside the frame. (Sunlight shining directly into our eyes can cause a similar condition.) Allowing some degree of flare to reduce the contrast in the region around the sun can actually make an image look more natural. Your HDR sequence may have a frame that's so dark it shows very little flare at all, but that's not necessarily the best frame to match.

▲ FIGURE 7-24 Clouds ignited by sunrise light are reflected in a pond below Columbine Lake, San Juan National Forest, Colorado. I kept the land dark to make the richly colored sky more believable; making the land midtone would have looked fake.

▲ FIGURE 7-25 Pyramid and Cathedral Peaks from the summit of 14,156-foot South Maroon Peak at sunrise, Maroon Bells-Snowmass Wilderness, Colorado. Created by tone-mapping a 32-bit TIFF in Lightroom.

- **Let shadows be shadows:** Compressing the tonal scale until the shadows and highlights have the same density screams "HDR!" Retaining small areas of pure black makes your images more believable so long as the subject matter allows it. Most high-contrast scenes do. Large areas of near-black shadows, however, can be unnatural, since our eyes can usually see good detail in broad shadow regions.

- **Maintain good local contrast in the highlights and shadows:** As I've discussed, our visual system does not analyze contrast globally. Instead, we analyze contrast locally, within regions, most notably highlights and shadows. According to both Fairchild and Livingstone, there's no easy way to define in a scientific sense what level of local contrast looks most realistic. Fairchild says, "Amazingly, we are pretty good at just looking at them (images) and making a judgment (and with fairly good agreement among observers)." When in doubt, go back to your bracketed set of images to see what level of local contrast you captured in the frame that's properly exposed for the region of interest. Remember that surrounding the target region with high-contrast subject matter will lower the perceived contrast of the target region. Surrounding the same target region with low-contrast subject matter will have the opposite effect. Strong overall contrast

▲ FIGURE 7-26 Crepuscular rays (god beams) from the summit of 14,267-foot Torreys Peak, near Georgetown, Colorado. Created by tone-mapping a 32-bit TIFF in Lightroom. Keeping the foreground ridge dark enhanced the apparent brightness of the clouds.

tends to make bright areas look brighter. For example, if you have the sun in the frame, letting a few shadows go dark will make the sun appear brighter, which will enhance the naturalness of the image's appearance.

- **When it comes to blending shadow and highlight regions into a believable whole, gradients can be your friends:** As you know by now, I love gradients. They're essential when employing the Rembrandt Solution, but also useful when tone-mapping your HDR images. Lightroom and Camera Raw both have a slick Graduated Filter that you can use when tone-mapping a 32-bit TIFF. Some dedicated HDR programs offer this option, as well.
- **Look at HDR images at all scales, from thumbnail to print size:** You're looking for two different problems here. One characteristic of an over-baked HDR is excessive textural contrast. You'll see this often in shots of old cars and abandoned factories, where the texture in the rust and peeling paint has a grungy, hyperreal quality. Excessive use of Clarity in Lightroom or Camera Raw can produce this look, as can any number of controls in dedicated HDR programs. The texture might look fine at screen size, but could be a problem once you zoom in to print size at, say, 16 × 24 inches. The second

problem concerns gradients. If you employ a digital graduated filter tool to help blend the highlights and shadows, take a look at the image at thumbnail size (the first size most people will see in this digital era). If the transition zone is too narrow, it can be obvious in the thumbnail even if the print-size image looks fine.

- **Beware of halos where dark objects meet bright backgrounds:** This is another dead giveaway of an over-baked HDR. HDR programs have gotten much better over the past few years at controlling halos, but if you compress the tonal scale too far, halos can still be an issue.

▾ FIGURE 7-27 North Maroon Peak from the summit of 14,156-foot South Maroon Peak at sunrise, Maroon Bells-Snowmass Wilderness, Colorado. Created by tone-mapping a 32-bit TIFF in Lightroom. I preserved the hazy bright appearance of the sky and land in the top-right corner of the image to mimic the veiling flare I saw as I was shooting.

Final Thoughts on Realism and HDR

In the days before digital, a film aesthetic ruled. Straight photographs were generally deemed realistic even though our eyes could see more detail in the highlights and shadows of the actual scene than the film could record. For a high-contrast scene in the film era, bright highlights and inky black shadows were considered realistic because that is what we were used to seeing. The invention of digital photography gave photographers greater control over highlight and shadow density, and the film aesthetic began to seem less realistic because it didn't capture the real-world scene as accurately as a digital sensor could.

Today's HDR software goes even further: it gives you total control over the density of every part of your frame, from the deepest shadows to the brightest highlights. This unprecedented power has opened the door for a new aesthetic, but this new aesthetic has not yet become widely accepted. Some people love HDR and the way it can render every part of the scene in rich detail; others hate it. For example, I've worked diligently to create an HDR rendition of a high-contrast scene that closely resembled what I saw, only to have other photographers tell me they thought the result looked quite unnatural. There is no consensus among landscape photographers about the best use of the incredible new tools at our disposal. Opinions on HDR vary, and the technology continues to evolve; in this period of flux, your best guide to producing a realistic image—one that represents what you saw during capture—will be your bracketed set of images, your knowledge of how our visual system processes high-contrast scenes, and your own good judgment.

FIGURE 8-1 Misty sunrise from the summit of Snowmass Mountain, Maroon Bells-Snowmass Wilderness, Colorado

8

Take a Walk on the Wide Side

It's a wide, wide world out there. Certain subjects just cry out to be photographed in a panoramic format. Many of my favorite images from my "Sunrise from the Summit" project, in which I photographed sunrise (or sunset) from the summit of all 54 of Colorado's 14,000-foot peaks, are panoramas. Something about that ultra-wide angle of view, sometimes as much as a full 360 degrees, captured the exhilarating, humbling, and awe-inspiring experience of being a tiny speck on top of the world.

The easiest way to shoot a panorama is to take a single frame and crop it to whatever aspect ratio works best for the subject. There's no law that says that an image composed within a 3:2 frame must be shown with that same aspect ratio. However, there are two disadvantages to creating a panorama with only a single frame. First, your shot is limited to the angle of view of your widest lens. For my 16mm lens, that's 97 degrees—wide, but not as wide as I often want. The second disadvantage concerns print size. Panoramas look good printed big, but the biggest print you can make is limited by the resolution of the single frame. The solution is to shoot a series of images, rotating the camera between shots so each frame overlaps the next, and then stitch all the frames together with appropriate software. With this approach, it's possible to create enormous panoramas—as much as 360 degrees wide—with great quality.

Setting up a Single-Row Panorama

The simplest panoramas to create consist of a single horizontal row of images. The key to shooting a single-row panorama that can easily be stitched together later is proper setup of the camera and tripod in the field. If you do a careful job there, the actual stitching of single-row panoramas is straightforward.

First, level the base of the tripod head by adjusting the length of the tripod legs. Check your work using your tripod's built-in level (if you have one) or a handheld level. You're leveling the plane on which the tripod head rotates as you pan across the scene. This is a crucial step; get it wrong, and a horizon that should be straight and level will look like a roller-coaster track. Next, level the camera forward, backward, and left to right using the in-camera level or a level in the hot shoe. I normally orient the camera vertically, which

▲ FIGURE 8-2 Full 360-degree panorama of moonset at sunrise from the summit of 14,059-foot Sunlight Peak, Weminuche Wilderness, San Juan Mountains, Colorado. Single-row panorama, 12 component images, 24mm tilt-shift lens in portrait orientation. I created each component image from a bracketed set of three images merged using the Rembrandt Solution. Today I would use the HDR technique described in Shooting and Processing High-Contrast Panoramas.

requires me to take more images to cover the width of the panorama, but it also gives me higher resolution in the final image. If the closest part of your subject is 50 yards away or more, this completes the physical setup.

Of course, the most interesting panoramas are typically those that include a strong foreground. If your composition includes elements close to the camera, there's another step required for setup: positioning the camera so it rotates around the nodal point of the lens. This step is necessary to prevent foreground elements from moving in relation to background elements as you rotate the camera, a phenomenon called *parallax*. To demonstrate this, hold up one finger and close one eye. Rotate your head back and forth while holding your finger stationary. Your finger will seem to move in relation to the background. This is because your eye is not centered on your head's axis

▸ FIGURE 8-3 Mt. Sneffels and the Sneffels Range from County Road 7, near Ridgway, Colorado, shot on 4×5 film and cropped to a panoramic format

of rotation. Rotating the camera when its eye (the lens) is not centered over the axis of rotation (the center of the tripod head) produces a similar result. Trying to assemble a panorama with serious parallax errors will befuddle even the smartest stitching software.

Rotating the camera around the nodal point of the lens requires purchasing some kind of specialized panorama head. The Really Right Stuff Pano Elements Package that I currently use is shown in figure 8-4. The package consists of two parts: the nodal slide, on which the camera is mounted, and the panning clamp, which is mounted on the tripod head. The L-bracket bolted to the bottom and side of the camera was an essential but separate purchase. Once the panning clamp is leveled using the normal ballhead controls, you don't need to touch those controls again. The panning clamp

allows the camera to pan back and forth with a level plane of rotation. By design, leveling the panning clamp also levels the camera left to right and front to back at the same time. This greatly simplifies setup. No more tedious adjusting of the length of each tripod leg to make the plane of rotation parallel to the ground, then leveling the camera as a separate step!

Finding the Nodal Point

Here's how to find the nodal point of your lens. First, create a situation in which some part of the subject is close to the lens, say, 18 inches or two feet away, while the background is at least 50 yards away. One easy setup is to tie a string to a branch or some other high support where you can see past the string to a well-defined landmark like a building or streetlamp. Hang a weight from the string to keep it from blowing in the wind. Now set up and level your camera as previously described. Adjust the nodal slide until you've positioned the center of the lens approximately over the axis of rotation of your tripod head. Now rotate the camera left to right. If the string appears to shift to the right in relation to the background, slide the camera forward (away from you as you look through the camera). If the string appears to shift to the left in relation to the background, slide the camera backward (toward you as you stand behind the camera). Find the position on the nodal slide at which the string appears to remain stationary in relation to the background as you pan the camera from left to right. You only need to noodle over nodal points once: this is a one-time test that will not need be repeated so long as you use the same camera and lens.

▾FIGURE 8-4 A single-row panorama setup showing the nodal slide and panning clamp

If you're working with a zoom, you should test several representative focal lengths, say, 16mm, 20mm, 24mm, 28mm, 35mm, and 50mm. You don't need to test every millimeter change in focal length. You may find that you don't have enough travel on the nodal slide to rotate a 70mm lens around the nodal point, but you're not likely to be shooting panoramas with very close-in foregrounds with a 70mm lens. Write the results on a small card and put the card in your camera bag. I printed mine on an adhesive label and attached it to the nodal slide itself, then protected the label with a clear peel-and-stick laminate available at any office-supply store.

◂ FIGURE 8-5 This pair of photographs demonstrates what happens when you rotate the camera with the axis of rotation passing through the camera body rather than the nodal point of the lens. Notice that the string appears to the right of the distant streetlamp in the image on the left, but to the left of the streetlamp in the image on the right.

◂ FIGURE 8-6 This pair of photographs demonstrates what happens when you rotate the camera with the axis of rotation passing through the nodal point of the lens. Notice how the string remains in the same place in relation to the distant streetlamp in both frames.

▲ FIGURE 8-7 Uncompahgre and Wetterhorn Peaks from an overlook along the Alpine Trail, Uncompahgre Wilderness, Colorado. Single-row panorama, three frames, 35mm lens in portrait orientation.

Camera Settings for Single-Row Panoramas

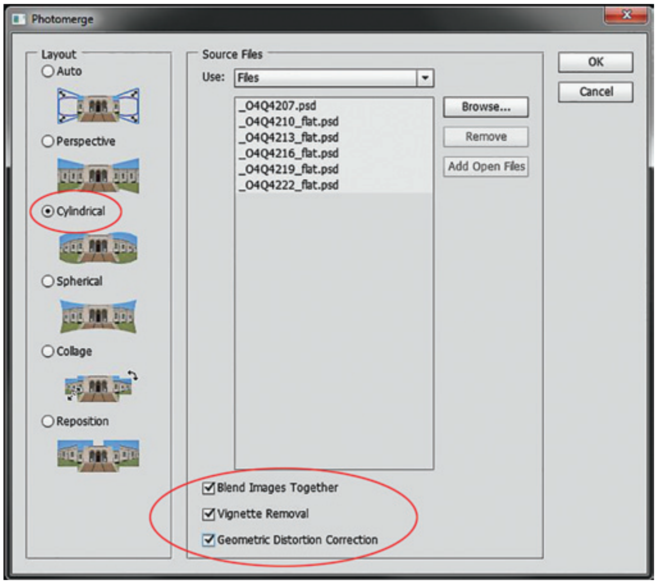
After perfecting your composition, leveling your camera, and positioning the nodal slide correctly, turn your attention to the camera controls. All controls should be on manual. Use manual exposure, manual white balance, manual ISO selection, and manual focus. Any change in exposure, color, depth of field, or focus point can make it impossible to stitch the images together. If possible, choose an exposure that will work for all frames in your panorama. If that's not possible, use the exposure strategy I'll discuss in the following sections. Compose generously, particularly with wide angles. When initially stitched together, the panorama will have scalloped edges. You'll need to crop it to give it a rectangular shape, so you'll lose some image area. You also have the option to use Content-Aware Fill in Photoshop to fill in the transparent area around the edges. This creates a rectangular panorama that doesn't require cropping. The software must invent pixels to do this, however, and the results can be bizarre. It's better to compose generously and crop away the scalloped edges.

Rotate the camera between shots so that each frame overlaps the next by about 30 percent. You don't need to use precisely the same amount of overlap for each successive frame. However, I prefer to rotate the camera by a precise number of degrees using the scale on the panning clamp and the table of lens rotation positions (left). It's quicker to use the scale when the light is changing fast than it is to look through the camera as I pan to the next camera position.

Lens	Rotation positions for vertically oriented, full-frame camera					
16mm	0°	40°	80°	120°	160°	200°
20mm	0°	35°	70°	105°	140°	175°
24mm	0°	30°	60°	90°	120°	150°
28mm	0°	30°	60°	90°	120°	150°
35mm	0°	25°	50°	75°	100°	125°
50mm	0°	20°	40°	60°	80°	100°

Stitching Panoramas

You can use Photoshop, as well as many other programs from simple and cheap to complex and expensive, to stitch your single-row panoramas together. At this time, you cannot stitch panoramas with Lightroom. If you have both Lightroom and Photoshop, however, you can select your images in Lightroom, then choose Photo>Edit In>Merge to Panorama in Photoshop. If you have Photoshop but not Lightroom, first open Bridge and select the images you want to stitch together. Then choose Tools>Photoshop>Photomerge. In the Photomerge dialog box, shown in figure 8-8, choose Cylindrical as the layout option, and tick the boxes for Vignette Removal and Geometric Distortion Correction. (Blend Images Together will already be ticked by default; leave it ticked.) Click OK, and Photoshop will produce your stitched panorama. If you've done everything right in the field, the result should be perfect, with no stitching errors, such as odd, blurry discontinuities in the boundaries of objects that should be smooth.



▲ FIGURE 8-8 The Photomerge dialog box in Photoshop. The Cylindrical layout choice and the three checkboxes that should be ticked are circled.

Shooting and Processing High-Contrast Panoramas

If you're shooting a very wide panorama, you'll probably have a broad range of light intensities across the scene. In those situations, HDR will be the only viable way to capture good detail in both the shadows and highlights. I start by setting the best compromise exposure for the frame that will be the middle of my panorama (unless that frame includes the sun, in which case I exclude the sun when metering). Normally I use the exposure recommended by the camera as a starting point. As with all panoramas, I set all camera controls to manual. Then I rotate the camera to the starting position, usually at the left end of the panorama. When the light hits, I shoot a three-frame bracket set with a two-stop bracket interval, so my exposures are –2, 0, and +2. I check my histogram for each bracketed set to make sure I've got the detail I want in the highlights and shadows. If necessary, I'll use exposure compensation to set the starting point for my bracketed set at –1 or +1 to ensure my lightest frame has good shadow detail and my darkest frame has good highlight detail.

▸ FIGURE 8-9 Full 360-degree panorama of Indian paintbrush and Meadow Mountain at sunset, Maroon Bells-Snowmass Wilderness, Colorado. Single-row panorama, 11 component images, 20mm lens in portrait orientation. I handled the high contrast by using the HDR technique described in Shooting and Processing High-Contrast Panoramas.

▾ FIGURE 8-10 Nearly 180-degree sunrise-to-moonset panorama from the summit of 14,087-foot Windom Peak, Weminuche Wilderness, Colorado. Single-row panorama, six frames, 20mm lens in portrait orientation. I handled the high contrast by using the HDR technique described in Shooting and Processing High-Contrast Panoramas.

After downloading the files, I merge each bracketed set into a 32-bit TIFF using appropriate software, such as the Merge to 32-bit HDR plugin for Lightroom that I described in chapter 6. Then I use Photoshop to stitch the 32-bit TIFFs into one giant panorama, still in 32-bit TIFF format. Note that you cannot export the images from Lightroom to stitch them in Photoshop and still preserve the 32-bit format because Lightroom will export them as 8-bit or 16-bit files (depending on your setting in Preferences—I recommend 16-bit). Once the 32-bit files have been created, you'll need to go to Bridge to select them and start the merging process using Tools>Photoshop>Photomerge. Finally, I tone-map the stitched 32-bit TIFF in Lightroom.

On occasion I've seen the stitching algorithm in Photoshop produce unacceptable results when stitching 32-bit files. In one case, the stitched image had a large section of blown-out sky even though the component images for the panorama had plenty of highlight detail. If you encounter a similar problem, try opening all of the 32-bit component images in Lightroom's Develop module. Be sure Auto-Sync is enabled, so that any change you make to one image will be applied to all the component images. Highlight the image with the most contrast (the one with the sun in the frame, for example) and begin editing it while keeping an eye on how your changes are affecting the other images. The challenge is finding a group of settings that works adequately for all of the component images, even though they may have very different degrees of contrast. This may require some trial and error. Once you're satisfied, go back to the Library module, select all the images, and choose Photo>Edit In>Merge to Panorama in Photoshop. Lightroom will convert your 32-bit files to 8-bit or 16-bit files, respecting all the Develop settings you applied, and send them over to Photoshop, which should stitch them into the final panorama with no further unpleasant surprises.

If you're shooting a 360-degree panorama, be sure to start the sequence by shooting the frame you'll want on the left side of the finished panorama. You're shooting a full circle, but the starting point still matters. By the time you work your way around the circle, enough time will have elapsed that clouds and sky color may no longer match up across the boundary between the first and last frames.

Photoshop sometimes seems to have a mind of its own when stitching 360-degree panoramas. Rather than starting the stitch with the frame you shot first (the one you want on the far left side of the panorama), it will pick an image from the middle of the sequence and start stitching from there. To solve this problem, locate the first image you shot (the one that will end up on the far left side of the finished panorama). Then locate the last image in the sequence (the one that will eventually end up on the far right). In the final panorama, the right edge of the far right image should end where the left edge of the leftmost image begins. Crop the right side of the rightmost image so it only overlaps the leftmost image by about five percent. Now when Photoshop stitches the images together, it will start with the correct image.

Multi-Row Panoramas

Multi-row panoramas are stitched together from an array of images rather than a single row. For example, you might shoot four rows of images, with each row containing ten images. The completed array would have four rows and ten columns. Single-row panoramas are much easier to set up, shoot,

▾ FIGURE 8-11 Panorama from Dead Horse Point, Dead Horse Point State Park, Utah. Single-row panorama, six frames, 35mm lens in portrait orientation.

◂ FIGURE 8-12 Milky Way panorama over Missouri Mountain and the Sawatch Range from the summit of Huron Peak, Collegiate Peaks Wilderness, Colorado. Multi-row panorama, 40 frames (four rows, 10 frames per row), 50mm lens in portrait orientation, each frame exposed at 13 seconds, f/1.4, ISO 6400.

and stitch together than multi-row panoramas, so why would you ever want to shoot a multi-row panorama?

There are two main reasons to consider shooting multi-row panoramas: mind-boggling resolution and the ability to shoot subjects that are both taller and wider than your widest lens can encompass. Multi-row panorama hardware also makes it easy to keep the plane of rotation horizontal when you're shooting single-row panoramas in which you point the lens up or down. In conjunction with fast lenses, multi-row panorama gear also opens up intriguing possibilities when shooting the Milky Way, as I'll discuss in the next chapter.

By stitching together multiple rows, you can create enormous files from which you can make huge prints with excellent quality. For example, I recently shot a Milky Way panorama from the summit of 14,003-foot Huron Peak. I used a 50mm lens and a multi-row panorama setup to shoot four rows with 10 images each. The complete panorama measures 15,513 × 27,784 pixels—big enough to make a 51 × 92 inch print at 300 ppi. The same shot illustrates the second virtue of multi-row panoramas: going wide both horizontally *and* vertically. Single-row panoramas let you go as wide as you want horizontally, even as wide as 360 degrees, but you are limited in vertical angle of view by the angle of view of your widest lens. The single-row panorama hardware I use automatically levels the camera from front to back. This limitation prevents me from pointing the camera down to look into a deep canyon or up to see more of the sky. Even with my widest lens, I can only look up 48 degrees or down 48 degrees (half the angle of view of my widest lens, since the camera is level from front to back). The Milky Way is a perfect example of a subject that is both wide and tall; a complete panorama can easily span an angle of 145 degrees left to right and 85 degrees vertically. Under the right circumstances, you could shoot a single-row Milky Way panorama using a 16mm lens on a full-frame camera and pointing the camera up, but ideally you would still use the same hardware and software required to shoot a multi-row panorama.

There are many ways to fudge the recommendations I've provided here. However, all of them come with the risk that the images will fail to stitch. You don't want to blow some magnificent opportunity by using an unreliable shooting procedure. I prefer to use and teach methods that I know will work.

You can see my current multi-row panorama setup, which was made by Really Right Stuff, in figure 8-13. This hardware lets you shoot multi-row panoramas while keeping the plane of rotation level. As with a single-row panorama, you must rotate the camera around the nodal point as you pan from left to right. You can find the nodal points of your lenses for a multi-row setup using the same procedure you used for single-row panoramas. In

addition to positioning the camera correctly from front to back using the nodal slide, you'll also need to position the camera correctly from left to right, so the pivot point of the rotating base passes through the center of the lens. It will be easier to stitch together your multi-row panorama if you use precisely the same increment of rotation while panning the camera horizontally, as well as when you position the "pitch" of the camera (the degree to which it is pointing up or down) in between each row. For example, when using a 50mm lens and a full-frame camera set vertically, I pan the camera 20 degrees in between each frame and use a 30-degree pitch in between rows. This gives exactly the same amount of overlap between each frame both horizontally and vertically.

As with single-row panoramas, you must use manual exposure, manual focus, manual white balance, and manual ISO so that the component images will stitch together seamlessly.

Whenever you shoot a panorama (either single-row or multi-row) with your camera tilted up or down rather than dead level, you're throwing a curve ball at Photoshop. Sometimes it will still hit a home run; other times, it will strike out. At this time, Photoshop is particularly unreliable when it comes to stitching multi-row panoramas and panoramas shot with tilt-shift lenses. For that, you need high-end, specialized stitching software. Although features vary from program to program, in general these specialized programs have two major advantages over Photoshop. The first is that some programs let you define the grid in which the individual frames will be placed. For example, you can specify how many rows and columns the grid has, the spacing in degrees between images both vertically and horizontally, the sequence in which you shot the images, and the pitch of the first row. This information allows the software to create a rough layout of the images, which is particularly useful if adjacent frames contain nothing but sky with no overlapping subject elements that the software can match up.

▲ FIGURE 8-13 My current multi-row panorama setup

The second advantage of some advanced programs is that you can add control points manually. Control points, which always come in pairs, mark the identical point in the overlapping portions of two adjacent frames. For example, the summit of Longs Peak might appear on the right side of one frame and the left side of the adjacent frame. By adding control points to the top of the summit cairn in both frames, you're telling the software to make those two points match up in the final panorama. If you can add three or more pairs of control points to each pair of images, you've given the software a good idea of how to match up the various subject features. The

software does its best to add control points automatically, but the ability to add additional control points manually makes it possible to complete difficult stitches that might otherwise require hours of tedious retouching by hand.

Learning to shoot and stitch panoramas from multiple frames will open up a new world of photographic possibilities. No longer are you limited to seeing the world through the rectangular frame defined by your viewfinder, with its rigid 2:3 aspect ratio. That view, as pleasing as it may be, is only the starting point in your search for the most evocative possible composition. Take a walk on the wide side, and you'll never again be content to see the world in just one way.

▲ FIGURE 8-14 Full 360-degree panorama of moonrise at sunset from the 14,083-foot summit of Mt. Eolus, San Juan Mountains, Colorado. Single-row panorama, 12 component images, 24mm tilt-shift lens in portrait orientation. I created each component image from a bracketed set of three images merged using the Rembrandt Solution. Today I would use the HDR technique described in Shooting and Processing High-Contrast Panoramas.

FIGURE 9-1 Milky Way over Mt. Sneffels, Mount Sneffels Wilderness, Colorado

9

The Landscape at Night

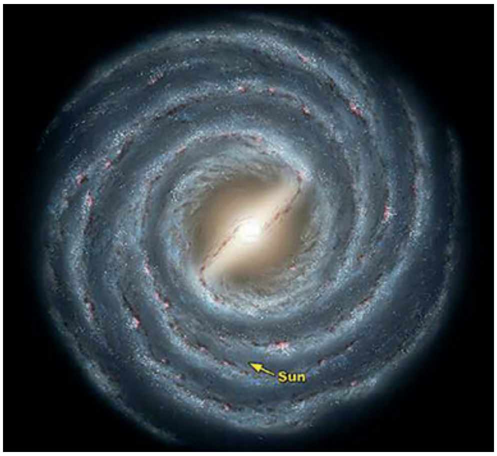
Today's high-end DSLRs have made it possible to make landscape photographs at night that were simply impossible in the film era. Film lacked the sensitivity to record the night sky as we see it, with apparently stationary stars. Exposures on even the fastest (most sensitive) film were usually so long that the stars made visible streaks as the earth rotated, rather than being rendered as points of light. True, some photographers used tracking devices to counteract the earth's rotation, but these were specialized tools not widely used by most shooters. The sensors in today's best DSLRs, by contrast, are so sensitive at their highest ISOs that photographers can capture the night sky using exposures short enough to record the stars as pinpricks of light. In short, we can now use readily available equipment to make photographs that capture some of that sense of wonder we all felt as children gazing up at the star-filled night sky.

Photographing the Milky Way

Of all the wonders of the night sky, the most spectacular subject for photographers who lack a telescope is surely the Milky Way. The only hardware required is a sturdy tripod, a DSLR with good high-ISO capabilities, and a wide-angle lens—the faster the better. This chapter will provide the other key ingredient: the information you need to make your own spectacular photos of the Milky Way.

Let's start with a refresher on your college astronomy class. We live in the Milky Way Galaxy, which is shaped like a plate, not a sphere. Our solar system lies part way between the center and the rim. The Milky Way is the band of light formed by billions of very distant stars that you see as you look along the galactic plane. You can see the Milky Way every clear, moonless night of the year, but it's not equally bright in all directions. If you look away from the center of the galaxy, you are looking through a region with relatively few stars. If you look toward the center of the galaxy, however, your line of sight leads past many more stars, plus clouds of interstellar gas and dust, so the Milky Way is much brighter and has more interesting structure.

The center of our galaxy, the most photogenic part of the Milky Way, lies in the direction of the constellation Sagittarius. Like any celestial object, Sagittarius appears to rise and set as the earth rotates. Sagittarius always



▲ FIGURE 9-2 An artist's conception of the Milky Way Galaxy, viewed from above. Image courtesy of NASA.

rises at an azimuth of 125 degrees and sets at an azimuth of 236 degrees at the latitude of Denver, but the time of rising and setting varies throughout the year. Sagittarius is most prominent in late spring, summer, and early fall (roughly April 1st to October 15th), and is not visible in winter because it is only above the horizon during the day.

Even the brightest part of the Milky Way is relatively dim. Get as far away from city lights as possible, and shoot on a clear, moonless night when the sky is as dark as it will get. That means shooting during the interval between astronomical dusk and astronomical dawn, when the sun is more than 18 degrees below the horizon. There are many websites and phone apps that provide moonrise and moonset times and the times of astronomical dusk and dawn.

The sky is always brightest near the horizon. It gets darker as you look higher into the sky. That's true at night as well as during the day. To make the best part of the Milky Way stand out against a dark sky, shoot when Sagittarius is as high in the sky as possible. Sagittarius reaches its highest elevation above the horizon, an altitude of 24 degrees as seen from the latitude of Colorado, when it is due south. As with any landscape, the best Milky Way photographs include more than sky. When planning your shoot, think about compositions in which you are looking roughly south at something interesting. Arches, sandstone towers, and dramatic peaks make good land elements. You don't need to worry much about foregrounds; the depth of field is so shallow at the wide-open aperture you'll be using that you won't want anything in the frame closer than about 15 feet, even with a 16mm lens. See the table below for the depth of field of selected lenses focused at infinity.

Depth of Field for Selected Lenses Focused at Infinity

Focal length/aperture	f/1.4	f/2	f/2.8
16mm	NA	NA	15 feet to infinity
20mm	NA	NA	23 feet to infinity
24mm	66 feet to infinity	47 feet to infinity	33 feet to infinity
50mm	282 feet to infinity	201 feet to infinity	150 feet to infinity

Depth of field for certain lenses mounted on full-frame cameras and focused at infinity. The circle of confusion is .02mm. This is a widely accepted standard for sharpness on the sensor.

To nail down the position of Sagittarius more precisely, download a desktop astronomy program. Skygazer (my current favorite), Stellarium, and Starry Night are three of the top contenders today. There may be others by

the time you read this. The best of these programs can pinpoint the position of Sagittarius at a particular time on any particular night, anywhere in the world. They can also show you the angle the Milky Way makes with the horizon, which varies depending on the time of night and the season of the year. For example, in the Northern Hemisphere, the Milky Way arcs up and left when Sagittarius transits. Transit is the time when the constellation is due south and as high in the sky as it will get, which is normally a good time to shoot. You'll generally want to position your most important land element—the mountain, tower, or arch—in the bottom-left part of the frame so that the Milky Way arcs up and over it. Like all constellations, Sagittarius is large in an angular sense. The brightest gas clouds in the Milky Way are actually about 10 degrees to the right of the position that Skygazer reports for Sagittarius. You'll need to take this into account if you want to position the Milky Way precisely, as I usually do. (Hey, my dad was a civil engineer—couldn't you tell?)

Focusing and Composing at Night

Once you arrive at your chosen location, you face the next challenge: focusing at night. Auto-focus is useless; turn it off completely so you don't accidentally trigger it. Nor can you simply set the lens to the infinity mark. That's usually not sharp enough either. Most modern lenses rotate past the infinity mark to allow you to focus at infinity even in extremely hot or cold conditions, so you can't just turn the lens barrel until it reaches its physical limit. Instead, point the camera toward a bright star, set the lens to infinity to get close to proper focus, engage live view, magnify the view to 10×, and focus manually on the star. You may need to disable exposure simulation in your live-view menu to actually see a star. If you arrive at your shooting location before dark, use live view to focus on something at infinity during daylight hours. In either case, be sure to tape the lens to lock-in infinity focus, then check focus again by shooting a test frame. Include a bit of the skyline when testing at night. It's often easier to check the sharpness of the skyline than the sharpness of a star.

Once you're confident you're focused at infinity, you can compose your shot. It's easier to compose if you first let your eyes adapt to the dark. I use the red LEDs on my headlamp when working at night to preserve my night vision as much as possible. Even better is to use no light at all by learning how to find the appropriate buttons on your camera by touch. Composition is largely a matter of guess-and-check, since you probably won't be able to see the Milky Way clearly through the viewfinder, although you may be able to distinguish horizon from sky. Level the camera left-to-right with a hotshoe level or your in-camera level (if you have one), point it in

approximately the right direction, and shoot a test frame. Adjust as needed and try again.

A good starting-point exposure for the Milky Way on a moonless night is 30 seconds, f/2.8, ISO 6400. But here's the catch: you need a 16mm lens on a full-frame camera to use such a long exposure without the stars forming streaks due to the rotation of the earth. The shorter the focal length, the longer the exposure you can use before the stars move noticeably. Refer to the maximum shutter speed chart (next page) to determine the longest non-streaking exposure you can use with different focal-length lenses. If you don't have this chart with you, you can divide 500 by the focal length of your lens to determine the longest acceptable shutter speed. For example, if you're using a 20mm lens, your longest non-streaking exposure according to the 500 rule would be 25 seconds.

◂ FIGURE 9-3 The Milky Way and Longs Peak reflected in Bear Lake, Rocky Mountain National Park, Colorado. I shot two frames with a 16mm lens at f/2.8, ISO 6400, and merged them with the modified Rembrandt Solution. I exposed the sky frame for 30 seconds and the land frame for 90 seconds.

◂ FIGURE 9-4 The Milky Way over the Maroon Bells, Maroon Bells-Snowmass Wilderness, Colorado. I shot two frames with a 24mm lens at f/1.4, ISO 6400, and merged them with the modified Rembrandt Solution. I exposed the sky frame for 20 seconds and the land frame for 80 seconds.

Maximum Shutter Speed Chart

This chart lists the longest shutter speed you can use with different focal-length lenses before the stars make noticeable streaks. The chart assumes you are using a full-frame camera with a sensor the size of a 35mm slide. If you are using a camera with a "sub-full-frame" or APS-C sensor, multiply the focal length printed on the lens by the appropriate crop factor or multiplication factor, then use the result as the focal length for the purpose of this chart. For example, if you are using a 16mm lens on a camera with a 1.5 crop factor, multiply 16 by 1.5 to get 24. The longest exposure you can make with that lens without visible star motion is 21 seconds. Note that this chart assumes you are viewing a print made at normal resolution for a high-quality print (file resolution of 240 to 300 ppi). If you zoom in to 100 percent on your monitor, you will see some very short star trails.

Focal length	Angle of view (horizontal dimension in landscape mode)	Angle of view (vertical dimension in landscape mode)	Maximum shutter speed to avoid visible star motion in a print
16mm	97°	64°	31 seconds
20mm	84°	56°	25 seconds
24mm	74°	50°	21 seconds
28mm	65°	44°	18 seconds
35mm	54°	36°	14 seconds
50mm	40°	27°	10 seconds
85mm	24°	16°	6 seconds

Holding Detail in the Land

▸ FIGURE 9-5 Looking south at the Collegiate Peaks and the Milky Way from the summit of Missouri Mountain, Collegiate Peaks Wilderness, San Isabel National Forest, Colorado. One frame, 17mm lens, 30 seconds, f/2.8, ISO 6400, shot eight minutes after astronomical dawn.

You'll find that with today's cameras, capturing the Milky Way by itself is relatively easy. Creating a compelling landscape photograph with detail in the land (rather than letting the land fall into black silhouette) is much more difficult. At high ISOs, even with today's best cameras, it's very difficult to open up deep shadows without generating unacceptable noise and peculiar color shifts. If there's lots of snow on the ground, you can get minimal detail in the land from starlight. To obtain more detail, shoot as long as 20 minutes before astronomical dusk or 20 minutes after astronomical dawn. The full moon will provide great detail in the land but it will wash out the Milky Way. A good compromise is to shoot when the moon is 15 to 30 percent illuminated and lighting the scene from the side. Avoid backlighting. Shooting by moonlight and shooting before astronomical dusk and after astronomical dawn create a tradeoff: brighter land means a dimmer Milky Way and vice-versa. You can try shooting at ISOs above 6400 if your camera offers them,

but the noise may be intolerable. The image on your LCD will probably give you a false impression of how much land detail you've actually captured. Go into your menus and turn down the LCD's brightness, and be sure to check your histogram.

Another approach to holding detail in the land is to throw money at the problem. Let me explain. The brightness of the image you can make at night in a single exposure before the stars make visible streaks depends on three factors: the highest ISO you can use without generating unacceptable noise; the focal length of the lens (the shorter the focal length, the wider the angle of view and the longer you can leave the shutter open); and the maximum aperture of the lens. The camera you use determines the first factor, but the last two are determined by the lens. Currently, the lens with the best combination of short focal length and large maximum aperture is a 24mm f/1.4. Expensive (but top-quality) versions of this lens are available from Canon and Nikon.

A 21-second exposure with a 24mm f/1.4 lens, shot wide open, will give you the best possible detail in the land without visibly streaking stars. If the land is composed of rock and snow, you should be able to get all the detail you need in a single exposure. If the land contains large areas of evergreen forests, which suck up light like black velvet, you'll probably want to turn to a modified version of the Rembrandt Solution even when using the best available lens.

As with the daylight version of the Rembrandt Solution, the basic idea is to shoot one frame for the highlights and one frame for the shadows, then combine the two images in Photoshop. At night, the idea is to shoot a frame with a shutter speed long enough to record detail in the land, ignoring the resulting star trails, then combine the correctly exposed land image with a correctly exposed sky image, taken with a short-enough exposure that the stars are sharp. Unfortunately, the standard version of the Rembrandt Solution allows star streaks from the good-shadow image to bleed through the sharp stars in the good-highlight image. Here's how to solve that problem.

Start the same way you'd do for the regular Rembrandt Solution, by stacking the two images as layers in Photoshop. One more time, here's the drill: if you have Lightroom, select both images, then choose Photo>Edit In>Open as Layers in Photoshop. If you don't use Lightroom, start from Bridge (which ships with Photoshop). Select both images, then choose Tools>Photoshop>Load Files into Photoshop Layers. If you don't use Bridge, start from Photoshop itself. Choose File>Scripts>Load Files into Stack and navigate to the appropriate files. Whichever method you use, the next task is to drag the dark (good-sky) layer to the top of the layer stack if it's not already there.

Here's where the procedure for the modified Rembrandt Solution diverges from the standard version. Choose the Quick Selection tool and select the sky. You don't need to get too fussy about making a perfect selection. Next,

▸ FIGURE 9-6 The Milky Way over Forest Canyon and the Continental Divide from the Rock Cut on Trail Ridge Road, Rocky Mountain National Park, Colorado. Stitched together from six pairs of images (two rows, three images per row), all shot with a 16mm lens, f/2.8, ISO 6400; all sky frames exposed for 120 seconds; all land frames exposed for 30 seconds; each pair merged with the modified Rembrandt Solution prior to stitching.

expand the selection by choosing Select>Modify>Expand. I usually expand the selection by 250 to 300 pixels when working with files from my 22-megapixel 5D Mark III, but you may need to experiment to see what value works best for your particular image and for the resolution of your camera.

With the top layer (the good-sky layer) active, add a layer mask by clicking the third icon from the left at the bottom of the Layers panel (the one shaped like a square with a circle inside). The image will look awful.

With the new mask targeted, go to the Properties panel and feather the mask by the same amount you expanded the selection. That should blend the good sky and good land images in a believable way.

As I discussed in chapter 7, the advantage of using this approach to feathering the mask is that you can reopen the image later and adjust the feathering if need be. The disadvantage is that you can't effectively refine the mask by painting on it. The same feathering value you've applied to the mask as a whole will also apply to the brush you choose to paint on the mask. If you choose a 30-pixel brush, for example, it will have a 250- to 300-pixel feather applied to it. That makes the edge of the brush so soft it's useless.

If you decide you need to refine the mask by painting on it, you'll need to take a slightly different approach. Instead of feathering the mask in the Properties panel, choose Filter>Blur>Gaussian Blur. Set a radius equal to the value you used to expand the selection. Now you can paint on the mask with predictable results. The only disadvantage of this approach (a minor one) is that once you save and close the image, the mask can only be modified by further painting and/or blurring.

Processing Milky Way Images

If you are shooting with a daylight white balance, you may be startled by the yellow-green color of the sky in your Milky Way shots. Even on the darkest night, the sky is never completely black. Instead, it exhibits a faint greenish glow caused by a variety of processes high in the atmosphere. We don't see the night sky as green, of course; in fact, we don't really see color at night at all unless we're looking at an object bright enough to excite the cones in our retinas. A few photographers show the night sky as their cameras record it when set to a daylight white balance. The majority of them, however, including myself, choose to change the white balance to restore the blue-black color we imagine the night sky to be.

The following are the basic steps I follow when editing a photograph of the Milky Way:

▸ FIGURE 9-7 An unprocessed image of the Milky Way from the summit of La Plata Peak, shot with a daylight white balance

1. I start in the Basic Panel in Lightroom, where I usually set the color temperature to about 3,200 degrees K and the tint to 10 to give the

sky a blue/black color. The exact settings vary depending in part on how much light pollution from nearby cities has affected the color of the sky.

2. In the Lens Corrections panel's Basic tab, I check Enable Profile Corrections and Remove Chromatic Aberrations.
3. In the Noise Reduction section of the Detail panel, I set Luminance to about 50 while examining the image at 100% magnification. The goal is to minimize noise while still retaining as much fine detail as possible. The exact value will vary depending on your camera and the ISO value you set.
4. The next step is to increase contrast in the sky to make the Milky Way stand out more. As a general rule, you don't want to increase contrast globally; that just makes the dark land even darker. For that reason, I use the Linear preset for Point Curve in the Tone Curve Panel, then add contrast to the sky using Lightroom's Adjustment Brush. For additional contrast, you can open the image in Photoshop, select the sky with the Quick Selection tool, and add a Curves adjustment layer. Pull the shadow portion of the curve down and push the highlight region up to add contrast.
5. While in Photoshop, you may wish to brighten the stars by using Unsharp Mask (Filter>Sharpen>Unsharp Mask) with a low amount setting and a high radius. I find that a setting of 30 for each value often works well. To confine the adjustment to the sky, make the good-sky layer a Smart Object (right-click on the layer and choose Convert to Smart Object). Now when you apply the filter, it will be applied as a Smart Filter, which will be accompanied by its own mask. Paint on the mask with black where you wish to hide the effect. As an alternative to this Unsharp Mask technique you can paint on Clarity with the Adjustment Brush back in Lightroom.

Shooting Milky Way Panoramas

Single-frame photographs of the Milky Way are beautiful, but the Milky Way offers other photographic possibilities as well. Look closely with dark-adapted eyes, and you'll see that the Milky Way forms a gigantic arch in the sky that extends from horizon to horizon. This arch is far too large, in an angular sense, to be captured in a single frame, even with the widest rectilinear (non-fisheye) lens. The best way to shoot it is as a stitched panorama with a multi-row panorama head.

▸ FIGURE 9-8 The processed version of the image in Figure 9-7

Shooting a Milky Way panorama is easiest in the spring just after Sagittarius has risen high enough to be above any foreground mountains. At that time of year, the Milky Way arch is relatively compact. The high point of the arch will be due east and considerably lower in the sky when the sky is fully dark and Sagittarius is in the right position than it will be later in the summer. For example, the top of the arch is roughly 50 degrees above the eastern horizon on April 1st at the ideal time of night but closer to 90 degrees on September 1st.

▾ FIGURE 9-9 The Milky Way over Mesa Arch, Canyonlands National Park, Utah. I created this image by shooting two complete, separate panoramas with a 16mm lens. Each panorama consisted of eight images (two rows, four images per row). One panorama was exposed for sky (30 seconds, f/2.8, ISO 6400); the second was exposed for land (120 seconds, f/2.8, ISO 6400). I merged the two panoramas manually in Photoshop, which was difficult because the two panoramas didn't align perfectly. A better solution would have been to shoot two frames at each camera position (one for sky, one for land), merge each pair with the modified Rembrandt Solution, then stitch the resulting composite images.

I discussed the tripod hardware needed for multi-row panoramas in chapter 8. My go-to lens for Milky Way panoramas is my 24mm f/1.4, which gives me the best land detail possible in a single frame, without showing star streaks. My second choice is my 50mm f/1.4, which gives me even higher resolution because it requires more frames to cover the height and width of the panorama. The disadvantage of using this lens is the greatly reduced depth of field. When focused at infinity, my 24mm lens at f/1.4 gives me about 66 feet to infinity; my 50mm lens at f/1.4 gives me 282 feet to infinity.

The problem of holding adequate detail in the land is exacerbated when you're trying to stitch together a panorama. Now you not only need to capture detail in a single frame, you also need to capture detail in exactly the same way in all frames so they will stitch together properly. My solution is to use the modified Rembrandt Solution I described previously, being certain to use the exact same settings for expanding the selection and feathering the selection edge for each pair of good-shadow and good-highlight images.

▲ FIGURE 9-10 The Milky Way over Longs Peak from the Emerald Lake Trail after an April snowstorm, Rocky Mountain National Park, Colorado. Multi-row panorama, 10 frames (two rows, five frames per row), 16mm lens, 20 seconds, f/2.8, ISO 6400.

I only need to do this for component images that contain the skyline—in other words, images where I want to blend properly exposed sky with properly exposed land. For component images that only contain land, I use only the good-shadow exposure in the stitched panorama. For component images that only contain sky, I use only the good-highlight exposure. I usually only have all-land or all-sky images if I'm using the 50mm lens, which has a relatively narrow angle of view. Once I've prepared all the Rembrandt Solution images, I flatten them and save them as TIFFs under a new name in a new folder along with all the land-only or sky-only images (if any), also saved as TIFFs. Then I point my favorite stitching program at the folder full of images and let 'er rip.

Here's one additional tip for assembling a multi-row panorama. As I mentioned above, I always check Enable Profile Corrections in the Basic tab of the Lens Correction panel in Lightroom. This will correct some, but not all, of the light falloff in the corners of a 24mm f/1.4 or 50mm f/1.4 lens shot wide-open. Areas of your panorama that have uniform tone, such as the sky or an evenly lit snowfield, can show odd, repetitive variations in brightness because the corners of the component frames are darker than the centers. To fix this, I usually add some additional vignette correction by going to the Profile tab of the Lens Correction panel and moving the Vignetting slider toward higher values. You'll need to experiment to see what is required for

your lenses; I use a value of 190 for my Canon 50mm f/1.4 when shooting wide open. Beware of opening up the corners so much that you create unacceptable noise and color shifts.

Don't let the technical details of a complex Milky Way shoot overwhelm the experience of being there. Take a moment during the shoot to turn off your headlamp and soak in the beauty of the night sky. It's the best way I know to truly appreciate the immensity of our universe.

▾ FIGURE 9-11 Cora Randall at Druid Arch, Canyonlands National Park, Utah. 24mm lens, 10-hour exposure, f/2.8, Kodachrome 64, with flash fill for foreground.

Photographing Star Trails

Back in the film era, the standard approach to capturing the night sky without employing a telescope with a tracking mount was to open the shutter and leave it open for a very long time. During that long exposure, which could extend for hours, the stars would make graceful streaks across the film as the earth rotated. Although recent DSLRs can now capture the night sky as we see it, with stationary stars, it's still lots of fun to create photos of star trails.

The direction you point the camera controls the shape of your star trails. Point your camera due north and include Polaris, the North Star, if you want your star trails to form concentric circles. Point your camera due south and include the ecliptic, the apparent path of the sun and planets through the sky, and you'll get a very different pattern. Stars right on the ecliptic will form trails that are nearly straight. Stars above and below the ecliptic will form trails that bend away from the ecliptic. Point your camera east or west and the stars will form trails leaning to the south (up and right as you face east; up and left as you face west).

Most subjects are easier to capture digitally than on film, but star trails are an exception. The easiest way to shoot star trails is still with an old film camera and color slide film. Pick a clear, moonless night, mount the camera on a solid tripod, open the shutter at astronomical dusk and close it again at astronomical dawn. An aperture of f/2.8 or f/4 usually works well. This approach will create beautiful star trails, but probably capture no detail in the land. To get detail in the land, try opening the shutter a little before astronomical dusk or leave it open after astronomical dawn. You'll have to experi-

ment with your favorite film to determine exactly when to open and close the shutter to provide detail in the land without washing out the sky.

Alas, this simple technique generates unmanageable noise if you try it with a DSLR. The standard digital approach is to make many long exposures with the shortest possible gap in between, stack the exposures, then blend them together so the star trails show through. At a minimum, you'll want to do 30-second exposures, but beware: two hours of 30-second exposures adds up to 240 frames. Stacking 240 high-megapixel images in Photoshop creates an unwieldy file that can reach 30 gigabytes or more in size. If each image has one or two hot pixels, and you stack 240 of them, as I did in one star-trails shot, you get hundreds of hot pixels in the final image. It took me half an hour to retouch all the hot pixels, and about 45 minutes each time I saved the file.

You'll simplify your life if you use the longest exposures your camera will tolerate without generating unacceptable noise. If possible, try to use exposures in the two- to four-minute range. Test your own gear to determine the longest exposure you can use without generating intolerable noise.

As for the other exposure parameters, try f/2.8 to f/4, ISO 200–400, depending on how many stars you want to capture. Higher ISOs and wider apertures will create more closely spaced star trails. Shooting at f/2.8, ISO 1600 will generate so many star trails you'll practically have more stars than sky. It's an effect you may consider cool, or it may strike you as over the top.

An intervalometer will allow you to program the exposure length, number of exposures, and interval between exposures, which should be one second. Start your star-trails sequence around nautical dusk, before the sky is totally dark, if you want a frame with some detail in the land.

After downloading all your exposures to your computer, your next task is to blend them so the complete star trails show through. There's lots of free or low-cost software out there that will do that. My preference, however, is to use Photoshop. In Lightroom, choose all the component images, then choose Photo>Edit In>Open as Layers in Photoshop.

The simple method of blending all the images so the star trails show through is to select all the layers (click the top layer, then Shift-click the bottom layer) and change the blend mode to Lighten. The Lighten blend mode compares the pixel in the target layer to the pixel directly underneath. If the pixel underneath is lighter, Photoshop allows that pixel to shine through. This will make all the star trails appear.

You can paint directly on your component images with black to remove unwanted elements in the land portion of the image, such as hikers who pass through your shot with their headlamps. There's no need to be fussy when painting, since everything black will be ignored by the Lighten blend mode. Identify the files with issues in Lightroom, then return to your layered

file in Photoshop and locate the offending files. Turn off the eye icon for all layers but the target layer. You can usually Alt-click on the target layer's eye icon to turn off all other layers with one click. Alt-click again to turn them on again. If that doesn't work, right-click on the eye icon and choose Show/Hide All Other Layers.

◂ FIGURE 9-12 Star trails over the Mummy Range, Rocky Mountain National Park, Colorado. 70 2-minute exposures with a 16mm lens, f/2.8, ISO 200.

◂ FIGURE 9-13 A jet trail across a two-minute exposure

Removing Jet Trails

The night sky is busier than you might think. During a two-hour star-trails sequence, you're guaranteed to have the lights of passing jets make long, continuous trails through the image. You can remove these jet trails with the Spot Healing Brush or Clone Stamp tool, of course, but that's tedious and can result in a blotchy look. In some cases, there's an easier way. First, identify the files that have jet trails and open them one at a time in Photoshop. Now choose the Pen tool. Click to place an anchor point at the beginning and end of the jet trail. This will create a straight path between the two anchor points.

◂ FIGURE 9-14 The initial path after placing the first two anchor points

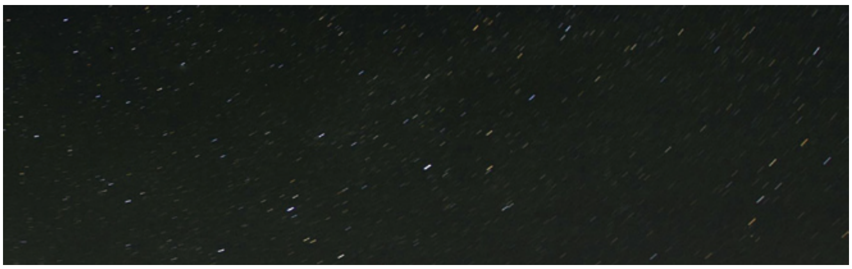
If the jet trail is perfectly straight, go to the next step. If not, switch to the Add Anchor Point tool and click to place a third point in the middle of the path (which will not be aligned along the jet trail yet). Click and hold on the new anchor point, and drag the point to the jet trail. Drag the ends of the handles that appear to make the path coincide with the jet trail. Initially, the

two handles are linked; moving one handle will adjust the other simultaneously. To adjust them individually, hold down Alt while you drag a handle. Once you've decoupled the two handles, you don't need to hold down Alt to continue to adjust them individually. In fact, holding down Alt a second time will recouple them. All this handle-dragging can be a bit tricky the first time you try it.

▸ FIGURE 9-15 The path after placing the central anchor point, dragging it to coincide with the jet trail, and adjusting the handles to align the path with the jet trail

Once the path coincides with the jet trail, choose the Spot Healing Brush. Select a hard-edged brush that's just a bit larger than the jet path. Be sure Content-Aware is selected as the Type. You don't actually use the Spot Healing Brush in the conventional manner; you just want to make sure the options are set correctly. Now, in the Paths panel, right-click on the work path you just created and choose Stroke Path. Be sure to choose the Spot Healing Brush in the Tool drop-down box. Click OK and the jet trail will disappear. You can now delete the work path. Do this for all your problem images before loading them into the layered Photoshop file.

▸ FIGURE 9-16 The star field after removal of the jet trail



Closing the Gaps

The simple approach of using the Lighten blend mode to reveal star trails has one disadvantage. Every star trail will show a tiny gap in between exposures. These gaps are not noticeable on the web or in a small print, but are rather annoying in a large print.

You might think that these gaps are inevitable; after all, there is a one-second interval between each exposure. However, nature photographer Floris Van Breugel has pointed out that these gaps will disappear if you use the Screen blend mode instead of Lighten. He has developed a slick technique for eliminating the gaps. First, set all your RAW files to neutral settings, with all settings in the Basic panel set to zero (no change in Exposure, Contrast, Highlights, Shadows, etc.). Set the Tone Curve to linear. Yes, the images will look bad. We'll fix that later.

Now select all the images and choose Photo>Edit In>Open as Layers in Photoshop. Make the first layer above the bottom layer of the stack active. Hit Control-J to make a copy. Choose the next layer above the new copy layer and make a copy of it. Make a copy of every other layer in the stack except the top layer. Do not make a copy of the top and bottom layers. Now target the top layer in the stack. Change the blend mode to Screen. You should see the star trails lengthen and the image get lighter. Hold down Shift and click the next layer below to highlight both the top and next-to-top layers simultaneously. Press Control-E to merge the two layers. Change the blend mode of the new merged layer to Lighten. Target the next layer below and change the blend mode to Screen. Again the star trails should lengthen. Hold down Shift and click the next layer below so you have two layers selected simultaneously. Press Control-E to merge the two layers. Change the blend mode of the new merged layer to Lighten. Repeat this procedure all the way down the stack. Each time you change the blend mode to Screen at the start of another repetition of this procedure, the star trails should lengthen. If they don't, you've done something wrong. Back up in the History panel until you know you're above where you made the mistake and try again. The photo at the end of the procedure will look flat and dull since you used a linear conversion of the RAW data. Increase contrast and adjust color and density to taste.

Photographing the Aurora

Words cannot truly convey the awesome experience of watching the aurora swirl across the sky. The aurora can be seen most frequently in the auroral zones, doughnut-shaped regions centered on the magnetic poles, so unfortunately for photographers based in between the southern and northern auroral zones, it's mainly an experience reserved for those willing to travel. Both the southern and northern auroral zones offer an excellent chance to see the aurora, but the northern zone is far more accessible to photographers in North America. Two recommended destinations with relatively easy logistics are Yellowknife, in Canada's Northwest Territories, and Fairbanks,

▸ FIGURE 9-17 Star trails over Bear Lake, Longs Peak, and Glacier Gorge, Rocky Mountain National Park, Colorado. 24mm lens, 243 30-second exposures, f/2.8, ISO 1600.

◂ FIGURE 9-18 Aurora over pond along the Prelude Lake Nature Trail, Prelude Lake Territorial Park, Northwest Territories, Canada. 25mm lens, 13 seconds, f/2.8, ISO 6400.

Alaska. Iceland is another popular aurora destination, but the weather is notoriously bad.

To see the aurora most vividly, the sky must be dark, which precludes arctic destinations in the summer months. Auroral activity tends to peak around the fall and spring equinoxes, which means late September and late March are good times for a trip. The most vivid displays often erupt in the hours around midnight, but they can occur at any time of night.

In Canada and Alaska the aurora most commonly appears in an arc of sky from northwest to southeast (moving clockwise around the compass). The ideal shooting location allows you to photograph in any direction within that 180-degree arc.

Unlike the Milky Way, which moves slowly, the aurora is in constant motion. Use the shortest shutter speed you can, consistent with good overall exposure, to keep the fine structure in the aurora from becoming smeared in your image. With an aurora of average brightness, a good starting-point exposure is about 10 seconds, f/2.8, ISO 3200. Check your histogram to be sure you are capturing adequate detail without blowing out the highlights (which is surprisingly easy to do). Engage the blinking highlight warning to double-check that you aren't clipping the highlights. Turn your LCD brightness to

▾ FIGURE 9-19 Aurora over Prosperous Lake, Prosperous Lake Territorial Park, Northwest Territories, Canada. 17mm lens, 5 seconds, f/2.8, ISO 3200.

its lowest setting to avoid getting a false impression about how much detail you've actually recorded. As always, your histogram is your best guide to correct exposure, not the image on your LCD.

The aurora's constant motion means you'll need to compose each shot separately while looking through the lens. You can't just point the camera in the general direction of the aurora and leave it set to that position. In order to see through the lens, your eyes must be as dark-adapted as possible, which means you should use a headlamp with red LEDs just as you should when shooting the Milky Way. Be sure to turn it off before making the exposure. At high ISOs, the light of even the dimmest headlamp will turn your foreground bright red. Be sure to remove any filters from your lens. Filter coatings can generate interference patterns in your image that are difficult or impossible to remove.

You'll want to focus carefully at infinity using the procedure I described for shooting the Milky Way. Once you've achieved critical focus, shoot a test frame, check that it's sharp, then tape the focus ring on the lens to prevent accidentally changing the focus. Then double-check the focus with another test frame. While you've got the tape out, put a couple of squares over the LED that lights up when your camera is writing data to the card. You should also tape the "active" light on your intervalometer, if yours is so equipped. When you're fully dark-adapted,

▲ FIGURE 9-20 Aurora over Prosperous Lake, Prosperous Lake Territorial Park, Northwest Territories, Canada. 17mm lens, 5 seconds, f/2.8, ISO 3200.

those lights are an annoyance. I've even seen the intervalometer's blinking "active" light cast a perceptible red tint over the foreground.

When the aurora is good, it's big (in an angular sense). I used my Canon 16-35mm f/2.8 lens exclusively when shooting the aurora during a recent trip to Yellowknife. I made about two-thirds of my aurora photos at 16mm.

Modern cameras are so sensitive at high ISOs that they can actually give you a fairly accurate meter reading from a bright aurora. I typically use manual exposure mode, but bias the exposure toward the plus side by one stop or occasionally more. For my Canon 5D Mark III, I discovered that the light of the full moon shining directly into the eyepiece, or even bouncing off my cheek and into the eyepiece, could alter the exposure. For that reason, I always set the exposure in manual mode while looking through the camera, and used my black-gloved hand to prevent stray moonlight from entering the eyepiece while metering.

One final tip: in cold weather, avoid breathing on either the viewfinder or the front element of your lens, and check both frequently for frost or condensation.

Can Night Photographs be Authentic?

Throughout my 20-year career as a landscape photographer, I have tried to make images I considered authentic. I have always told my customers, "What you see in my prints is what I saw through the lens." Then I bought a camera with an extraordinarily sensitive sensor, the Canon 5D Mark III, and started shooting landscapes on moonless nights when the only light sources were starlight and sky glow. The images revealed an amazing abundance of stars as well as the detailed structure of the Milky Way. Suddenly I faced a conundrum: how can I claim that my prints reveal what I saw through the lens when it's so dark that I can't see anything through the lens?

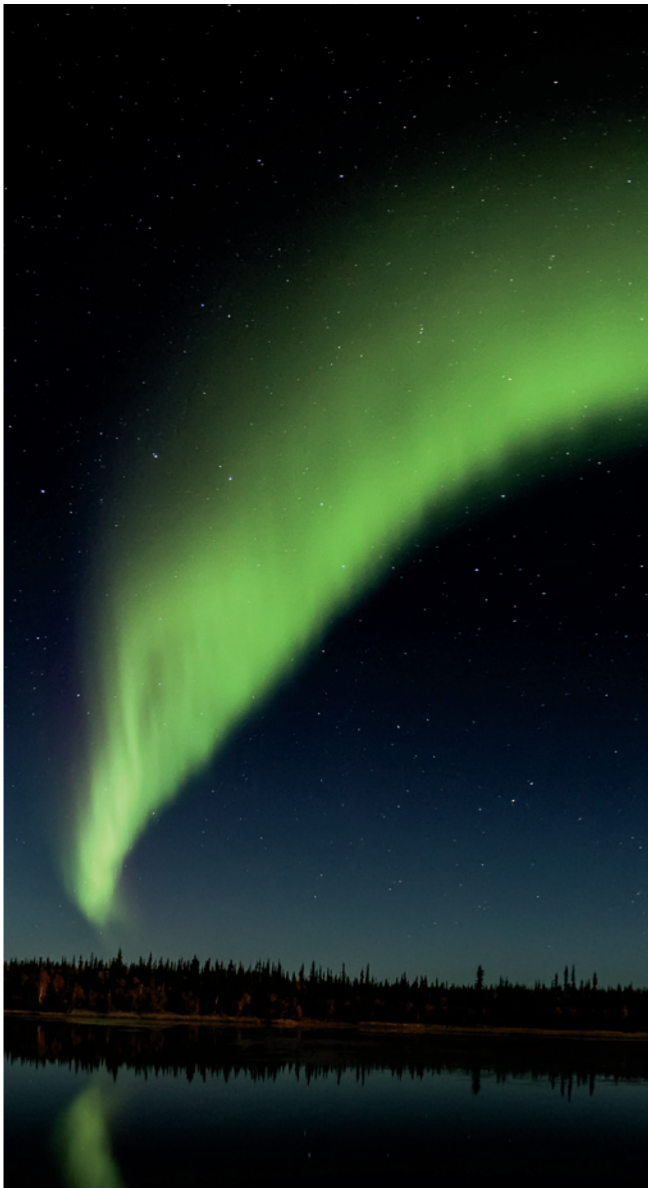
In a way, the problem is ironic. For decades I have battled the limitations of the capture medium. My philosophy was never, "What you see in my prints is what the film recorded." That was always unsatisfying because my eyes could always see much better detail in the highlights and shadows than film could capture. A good DSLR has much better dynamic range than transparency film, but it's still not as good as my eyes. High-dynamic-range techniques make it possible to capture an even wider range of brightness levels than my eyes can see, but also introduce their own problems, since our visual system doesn't see high-contrast scenes in a simple, linear way. As we've seen, turning an HDR image into something our visual system finds believable is fraught with challenges.

▲ FIGURE 9-21 Lone Eagle Peak and the Milky Way reflected in Mirror Lake, Indian Peaks Wilderness, Colorado. Multi-row panorama, 24 frames (four rows, six frames per row), 50mm lens, 13 seconds, f/1.4, ISO 6400.

Now for the first time I had a camera that was better than my visual system, at least in terms of its ability to record extremely faint light with a long exposure at a very high ISO. My new camera also revealed something less appealing about the moonless night sky: light pollution from nearby cities, coupled with naturally occurring sources of light high in the atmosphere, meant that the sky was actually a muddy greenish-yellow-brown, not the pleasing midnight blue we think we see at night. Recreating that nighttime feel requires changing the white balance in Lightroom to about 3,200 degrees Kelvin, a setting normally reserved for shooting under the yellow-orange light of old-fashioned incandescent bulbs.

At first I was stymied. How could I justify changing the white balance away from the daylight white balance I always used for photographing landscapes during the day? Then I did a bit of research into human night vision.

Our retinas have two types of light-sensitive cells, rods and cones. Cones are for color; rods can only detect luminance values, or shades of gray. Rods are much more sensitive to light than cones, so they are most active at night when our cones become inactive. On a truly dark, moonless night, we are essentially colorblind unless we're looking at something that generates light and reactivates our cones, such as a bright star.



Why, then, do we think of the night sky as being a deep blue? The concept of memory colors, which I discussed in chapter 7, may give us a clue. We tend to remember the colors of certain very familiar objects, such as the sky, as being different from what they actually were. Perhaps that intimate, lifelong association of the color blue with the sky helps us imagine that the night sky is blue even when it's too dark to distinguish colors, and even when the actual color is

far from blue. Shooting in color at night is like shooting in black-and-white during the day. What shade of gray best represents midday blue sky? Or Longs Peak? Or a weathered tree? Any shade of gray that looks good! In a similar way, what shade of blue best represents the moonless night sky? Any shade of blue that looks good!

When working at night, I use a bright white headlamp to navigate to my shooting location. Only the brightest stars are visible—the Milky Way can't be seen when the headlamp is on. Once I arrive, I switch to my headlamp's red LEDs to let my eyes adapt to the dark. When they are fully dark-adapted, a process that normally takes 20 to 30 minutes, the true glory of the night sky begins to become apparent. I can see the Milky Way clearly, as well as many more stars. Given the limitations of human vision, my goal when editing images shot at night is to re-create that nighttime feel rather than make an objective record of what I actually saw.

▾ FIGURE 9-22 A swirling aurora cradles the full moon, Prosperous Lake, Prosperous Lake Territorial Park, Northwest Territories, Canada. Single-row panorama with five frames, 17mm lens, 4 seconds, f/2.8, ISO 3200.

10

The Psychology of the Compelling Landscape

For some photographers, making images that satisfy only themselves is enough. Others define success to mean accolades from friends and family. For professional landscape photographers, of course, the most critical measure of success is sales. It's not enough to make images that capture their visual peak experiences in a way that satisfies only them. Pros must make images that speak to a wider audience. That's easier said than done. Even highly experienced photographers find it very difficult to predict which of their images will truly resonate with viewers. Understanding the psychology of the viewer can help both pros and dedicated amateurs with that task.

I began producing prints of my Colorado landscapes in 1994. Soon I was making much of my income selling matted-and-framed prints in various galleries and gift shops. Each autumn, in preparation for the Christmas rush, I would look back through the previous year's work and try to decide which new images to introduce. Even after several years of experience, however, my ability to predict which images would sell was poor. In a typical year, half of my new images failed to sell, and half succeeded. One year I decided to see if I could improve those dismal results by conducting focus groups with neighbors and my wife's colleagues. These people weren't familiar with my work, so I presented the group with a mixture of best sellers and new images, and asked them to rank the images according to what they would be most likely to purchase. I figured that if a new image got the same ranking as an established, popular image, I could confidently offer the new image for sale and watch the money roll in.

It didn't work out that way. In many cases, best sellers received low rankings. How could that be? I was baffled. Clearly, however, I could not rely on the results of the focus group to predict which images would succeed.

One of the insights of modern psychology is how much our preferences and decisions are driven by unconscious processes. Often our conscious mind merely provides rationalizations for decisions our unconscious mind has already reached. Solid evidence of the power of the unconscious comes from a study, conducted by advertising researcher Bruce Hall, that used my images. Hall gathered a group of my Colorado landscape images that had been offered for sale as prints. Some had succeeded; others had flopped. Hall showed them to a group of colleagues and asked them to rank the images in order of preference. During the viewing session Hall recorded their heart

◂ FIGURE 10-1 Cow parsnip and the Maroon Bells, Maroon Bells-Snowmass Wilderness, near Aspen, Colorado

rates and skin conductance, both of which correlate with emotional arousal and involvement.

Some colleagues had near-zero interest in the category of Colorado landscape photos. Others had a moderate interest. Regardless of their level of interest, the test subjects were about equally likely to predict (or fail to predict) which images would sell. In fact, only one-third of the variation in sales could be explained on the basis of the stated preferences of the test group.

◂ FIGURE 10-2 Wildflowers, Dallas Peak, and Blue Lake, Mount Sneffels Wilderness, San Juan Mountains, Colorado. I used a 16mm lens placed just 18 inches from the flowers to emphasize them instead of the dangerous-looking peaks in the distance.

Things got even more interesting when Hall examined the data on heart rate and skin conductance. For those subjects with no interest in landscape photography as a category, there was almost no correlation between the physiological measures and sales. For those subjects who were interested, however, there was a significant correlation between these physiological measures, which represent unconscious emotional reactions, and how well a particular print had sold. In his book *How Advertising (Sometimes) Works*, Hall wrote, "Why is this significant? It demonstrates the critical importance of relevance in triggering emotional responses from respondents. If the stimulus is not relevant to them, consumers will not focus their attention on it. And if they are not attentive, they will experience no meaningful perception." More broadly, Hall concludes that roughly two-thirds of the decision-making process in sales of prints is driven by unconscious processes. He then quotes legendary adman David Ogilvy, who once said, "Consumers do not behave as they say, they do not say what they think, and they do not think what they feel."

▴ FIGURE 10-3 Fireweed and the Maroon Bells, Maroon Bells-Snowmass Wilderness, Colorado. Flowers connote fertility; the lake confirms that water, one of life's essentials, is abundant and close at hand.

Landscape Photography and Evolution

If the unconscious is a primary driver of preferences in landscape photography, where do those unconscious preferences come from? One plausible possibility is evolution.

We have a lot in common with other mammals. We need food and water. We need shelter from storms, severe cold, and heat. We need refuge from

▲ FIGURE 10-4 Indian paintbrush and Maroon Peak from Fravert Basin at sunset, Maroon Bells-Snowmass Wilderness, Colorado. To a Pleistocene hunter, a lush meadow like this one would have been an attractive hunting ground.

predators and enemies. To find food, water, and shelter, we need to explore our environment. Meeting these needs was crucial as we evolved on the plains of east Africa.

Nearly all animals have a preferred habitat. Many, in fact, are adapted to only one type of habitat and will die if that habitat disappears. Could it be that humans also have a preferred habitat?

At first blush, that seems absurd. Humans now live in almost every possible environment, from the tropical parts of South America to the South Pole. How can I argue that we have a preferred habitat?

Some researchers in the field argue that we still have a preferred habitat and that it hasn't been long enough, in an evolutionary sense, for those

preferences to disappear. It's only been 125 generations since the Bronze Age and 250 generations since the Stone Age. The first creatures we can identify as hominids were ape-like creatures who descended from the trees and began living on the ground during the Pleistocene. We evolved for 80,000 generations on the plains of East Africa. The fact that we no longer need to hunt down dinner every day while simultaneously avoiding predators and enemies doesn't mean that all those instincts, tastes, and needs have disappeared. In his book *The Art Instinct*, New Zealand philosopher Denis Dutton cites J. B. S. Haldane's 1927 calculation that "a (genetic) variant that produces on average 1% more offspring than its alternative allele would increase in frequency from 0.1% to 99.9% of the population in just 4,000 generations." In other words, even a small preference for landscapes that more readily satisfied human needs could easily have become embedded in the genes of virtually the entire population. Those preferences still linger, even if not everyone can act on them and live where they would truly prefer.

Dutton goes on to point out that European pigeons introduced into New Zealand still instinctively fear snakes even after 200 pigeon generations, although there are no snakes in New Zealand and never have been. Once while hiking to a photo location in southeast Colorado I heard a rattlesnake sound its warning. I nearly jumped out of my skin, although I had never before heard a rattler in the real world and the snake turned out to be only about 18 inches long. My wife and daughter are phobic about spiders although neither has ever been bitten by one.

More than we care to admit, we are creatures of our evolutionary past. What does that mean in terms of our appreciation of landscape, and by implication, landscape photographs?

Jay Appleton, a geographer at the University of Hull in England, has written a book called *The Experience of Landscape* in which he laid out an evolutionary perspective on what types of landscapes we find pleasing. His ideas can be summarized in the form of three theories: habitat theory, prospect-refuge theory, and the savanna hypothesis.

Habitat theory postulates that we take pleasure in landscapes that look like they could satisfy our biological needs. Prospect-refuge theory asserts that we like landscapes that offer a *prospect*, to use Appleton's term: a long view, often from an elevated vantage point. But we also need to escape predators, hide from enemies, and take shelter from severe weather, so we look with favor on landscapes that offer potential refuges. The savanna hypothesis asserts that we prefer landscapes that resemble the plains of East Africa where we evolved. At that point in our evolutionary history, the savanna was much wetter than East Africa is today.

Gordon H. Orians, professor emeritus of biology at the University of Washington, lists the following characteristics of an idealized human habitat, which bears a striking resemblance to the savannas where we evolved:

- open spaces of low grasses interspersed with thickets of bushes and groupings of trees
- the presence of water directly in view, or evidence of water nearby or in the distance
- an unimpeded view of the horizon in at least one direction
- evidence of animal and bird life
- a diversity of greenery, including flowering and fruiting plants

Humans are less attracted to absolutely open, flat grasslands and more attracted to moderately hilly terrain. In other words, we like landscapes

▾ FIGURE 10-5 Roseroot in Silver Creek Basin, Treasure Mountain and Treasury Mountain at sunset, Maroon Bells-Snowmass Wilderness, Colorado. The flowers, elevated vantage point, widely scattered trees, and evidence of water in the distance (the shallow valley along the right side of the frame) would have appealed to our ancestors. These features are still enticing today.

where we can see opportunities to hike to the top of a hill and check out our surroundings, or, better yet, landscape photographs taken from elevated vantage points that directly reveal the lay of the land. Including the horizon helps us orient ourselves in space, which adds still more appeal. We also like landscapes that invite exploration, where we feel we could walk right into the frame and stroll along the grassy bank of a stream or lake or follow a path around a bend. We prefer savannas that are green rather than ones that are brown and dry. Stephen and Rachel Kaplan, professors of psychology at the University of Michigan, have shown that the most desirable landscapes have a moderate degree of complexity. Extremely intricate landscapes, such as impenetrable forests and jungles, are just as unattractive as utterly simple landscapes, such as prairies.

▲ FIGURE 10-6 Rough mule's ears and the Three Gossips, Sheep Rock, and the Organ, Arches National Park, Utah. Rare spring blooms add appeal to a dry landscape, which can appear harsh and unforgiving.

If greenery is so popular, should we all stop shooting in the desert? One study of Phoenix residents' preferences in terms of landscaping around their homes found that they all said they liked desert landscapes; however, if given a choice, money being no object, most said they preferred a green lawn rather than xeriscaping. They liked the idea of creating a little oasis to

▲ FIGURE 10-7 The mist rising from the valley below adds an element of mystery to this image of Kit Carson Peak, seen from the summit of 14,294-foot Crestone Peak at sunrise, Sangre de Cristo Wilderness, Colorado

live in. Many of the best desert shots show rare spring blooms, or a little bit of water—scenes that are certainly not typical of the desert's appearance for most of the year. According to Dutton, research has shown that women prefer their landscapes lush and green, with plenty of flowering and fruiting plants as evidence of the land's fertility, plus an ample supply of potential refuges. Men prefer landscapes that offer vast vistas, invite exploration, and look like rich hunting grounds.

The Kaplans have also pointed out that we like our landscapes to have an element of mystery, which they define as a feeling that "one could acquire new information if one were to travel deeper into the scene." I think we like mystery for an additional reason: it allows us to imagine a story about the image. Suggesting a story is easiest to do with photographs of people, since we can imagine their trials and triumphs just by studying their faces and surroundings, but the same principle can work in landscapes that show peaks or canyons half obscured by clouds or fog.

Prospect-refuge theory offers an intriguing way to think about why some images succeed and others fail. It may help explain the enduring appeal of frame-within-a-frame compositions, which place two foreground elements, such as trees or rock pillars, on either side of the frame, with a more distant view revealed in between. These framing elements partially conceal the viewer and help prevent discovery by potential enemies and predators, but still allow a view into the distance. Frame-within-a-frame compositions

are even more attractive if they place the viewer at some height above the surroundings. As Dutton points out, "Human beings like a prospect from which they can survey a landscape, and at the same time they enjoy a sense of refuge. A cave on the side of a mountain, a child's tree house, a house on a hill, the king's castle, the penthouse apartment, and a room with a view are situations with appeal (in fact, with a few exceptions, higher-elevation real estate for housing is more expensive worldwide)." Dutton goes on: "In fact, most landscape representation in the history of painting places the implied viewer either at some desirable vantage point—a cliff edge, perhaps, typically looking down into a valley—or, if at ground level, at a somewhat greater height than what would be accurate for a six-foot human being."

▲ FIGURE 10-8 Longs Peak and Bear Lake in spring, Rocky Mountain National Park, Colorado. Frame-within-a-frame compositions like this one let viewers imagine that they can see without being seen.

Although an elevated vantage point is often desirable, photographers don't need to climb to the top of a peak to use a mountain as a prospect symbol. Simply including a mountain in the frame lets us imagine ourselves on the summit enjoying a view that seems to go on forever. The sensation of a prospect can be created in other ways as well. Clear air coupled with a distant horizon also creates a long view—a long "fetch" to use Appleton's term—and encourages speculation about what may lie beyond the horizon. Such long views tend to draw the eye, which can be important in terms of guiding the viewer's gaze around the frame. Aerial photographs may give an extreme sensation of prospect, but at the cost of any sense of participation in the landscape below.

Refuge has no meaning without a hazard to take refuge from. People love the thrill of coming close to peril without really being in serious danger. Some kids love to be scared just a little bit. Many people love roller coasters for just this reason. We love to be perched on the edge of a thundering waterfall. Photographs that show violent weather approaching, but that include something in the scene that indicates you can still find shelter, have perennial appeal. Cliffs, steep peaks, large breaking waves, powerful rapids, and deep chasms are all reliable hazard symbols. Shadows, on the other hand, are ambiguous. They are hazard symbols if they appear to conceal a threat, but refuge symbols if they look like a place where the viewer can hide. Pair

▲ FIGURE 10-9 This image of Whitehouse Mountain, in Colorado's San Juan Mountains, combines a powerful hazard symbol (the threatening storm) with a symbol of hope (the sun's last rays igniting the aspen grove) and the prospect of refuge among the grove's sheltering branches

strong hazard symbols with powerful refuge symbols in a landscape image, and you may have a winner.

By now you may be thinking, "Don't people have different tastes around the world? After all, Japanese gardens don't look like British gardens." While this is true, it does not, according to Appleton, disprove his hypotheses. He writes, "Taste is an acquired preference for particular methods of satisfying inborn desires." Research has shown a surprising degree of uniformity in the types of images preferred around the world. In 1993, Vitaly Komar and Alexander Melamid, two Soviet artists who had taken up residence in the United States, received a grant to do a worldwide study of preferences in paintings. Dutton described the results: "People in very different cultures around the world gravitate toward the same general type of pictorial representation: a landscape with trees and open areas, water, human figures, and animals. More remarkable still was the fact that people across the globe preferred landscapes of a fairly uniform type: Kenyans appeared to like landscapes that more resembled upstate New York than what we might think of as the

present flora and terrain of Kenya." Although some dismiss this as the influence of the worldwide calendar industry, Dutton sees the hand of evolution at work. He sums up habitat theory and its corollaries well: "In the Pleistocene, habitat choice was another factor determinative of life and death, and emotional indifference to landscapes is as evolutionarily unlikely as indifference toward snakes, dangerous precipices, and poisonous foods, on the one hand, or sex, babies, and sweet and fatty foods, on the other."

▲ FIGURE 10-10 Blue-pod lupines below West Maroon Pass, Maroon Bells-Snowmass Wilderness, Colorado. Images like this one, which portray the wilderness as a gentle and welcoming place, can speak to a broad audience.

On Culture and Creativity

I'm certainly not arguing that evolution explains all of our unconscious preferences in landscape photographs. Culture clearly plays a crucial role. In the Middle Ages, wilderness was something to be feared and shunned; in colonial America, it was something to be conquered, which usually meant chopping down all the trees and altering its character completely. The appreciation

of wilderness as something beautiful and soul-restoring only took root in popular culture over the last hundred years or so. Today a photograph that portrays wilderness as gentle and welcoming is often appealing.

We appreciate good landscape photographs for other reasons as well. We find them appealing because of the formal beauty of their graphic design. We enjoy them if they capture some superlative: the reddest sunset, deepest snow, most expansive field of wildflowers, or richest fall color, although a great landscape photograph doesn't have to embody some superlative to succeed. We also value a landscape image if it showcases a view we've never seen before. At this point in my life, I'll never make it to the summit of Mt. Everest, so a photograph from the summit is fascinating to me even if it was taken with a cell phone camera. We treasure a landscape photograph if it is iconic, a single image that sums up a complex whole. And we love landscape photographs that are creative.

It's important to distinguish between photographs that are merely different and those that are genuinely creative. Different is easy; creative is hard. An image that is merely different strikes the viewer as odd or puzzling. An image that is creative impresses the viewer as something much more. In his book *How Advertising (Sometimes) Works*, Bruce Hall gave a definition of creativity that rang true for me: "Creativity is the connection that occurs when seemingly unrelated ideas collide and bond in a new, logical, and suddenly obvious way. Often, a person with a rich mental data bank of experience and knowledge may act as the catalyst. When that person's disparate brain regions are granted the time and opportunity to share some of that seemingly unrelated knowledge and data, the result may be a connection no one has ever made before, which provides a creative solution to a previously insoluble problem."

What struck me about this quote is the idea that creativity does not emerge fully formed from the void. Instead, it emerges when someone makes a new connection between the countless bits of information already stored in their head. In this book I have tried to impart a deep and broad knowledge of the many elements of landscape photography. I have tried to explain *why* something works or is true, rather than simply presenting techniques without explaining how they work. I believe it's easier to remember a procedure or principle if you know why it works, and not merely that it does work. I also believe knowing *why* something works fosters creativity. If you understand the whys, you can more easily visualize connections between apparently unrelated facts and ideas. If you can visualize many possibilities, you stand a better chance of hitting on the one that will be genuinely creative. And when that happens, you will truly have mastered the art, science, and craft of great landscape photography.

▸ FIGURE 10-11 Sunset on Owl Creek Pass, Uncompahgre National Forest, Colorado

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